FIG.1

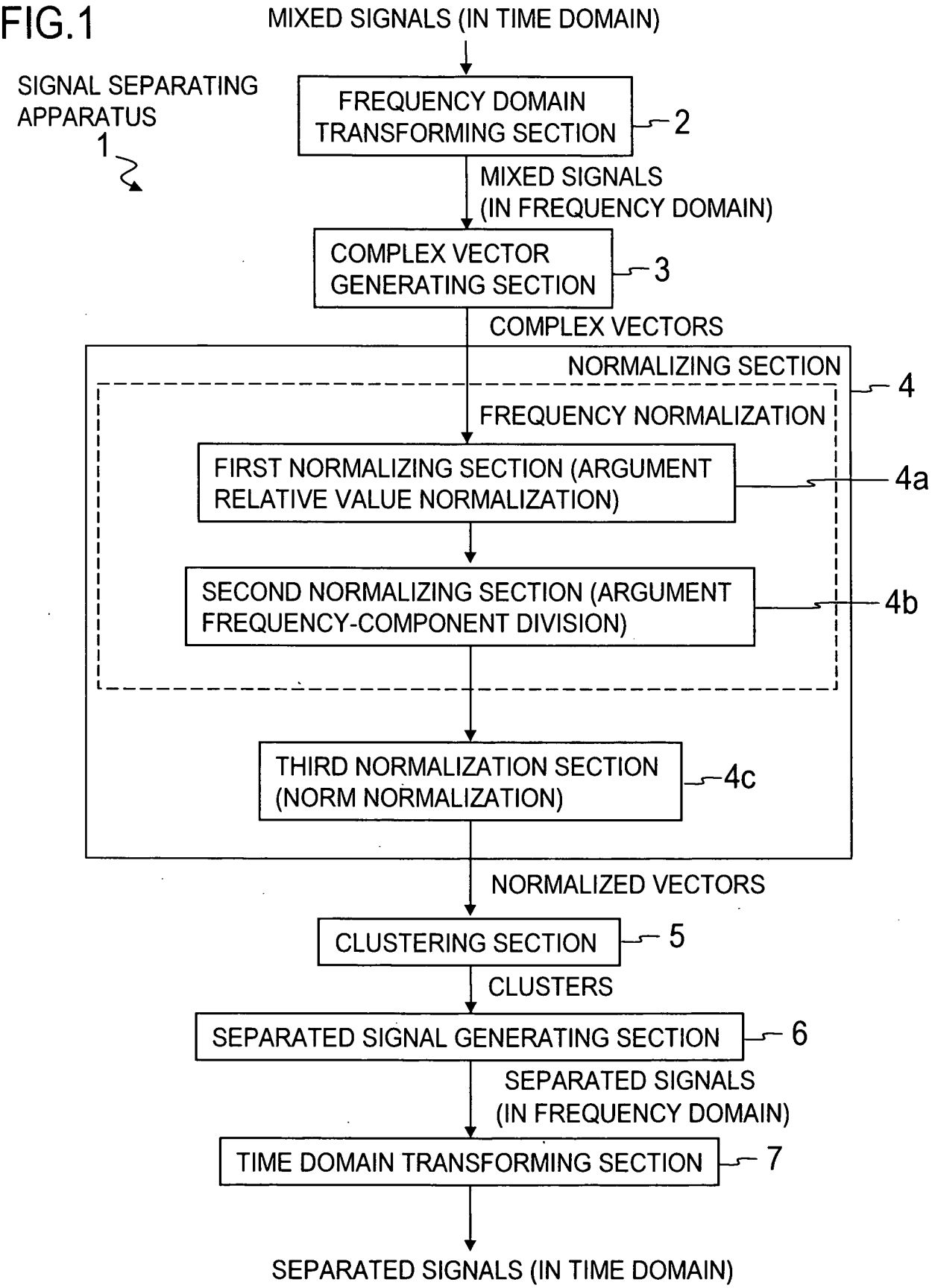
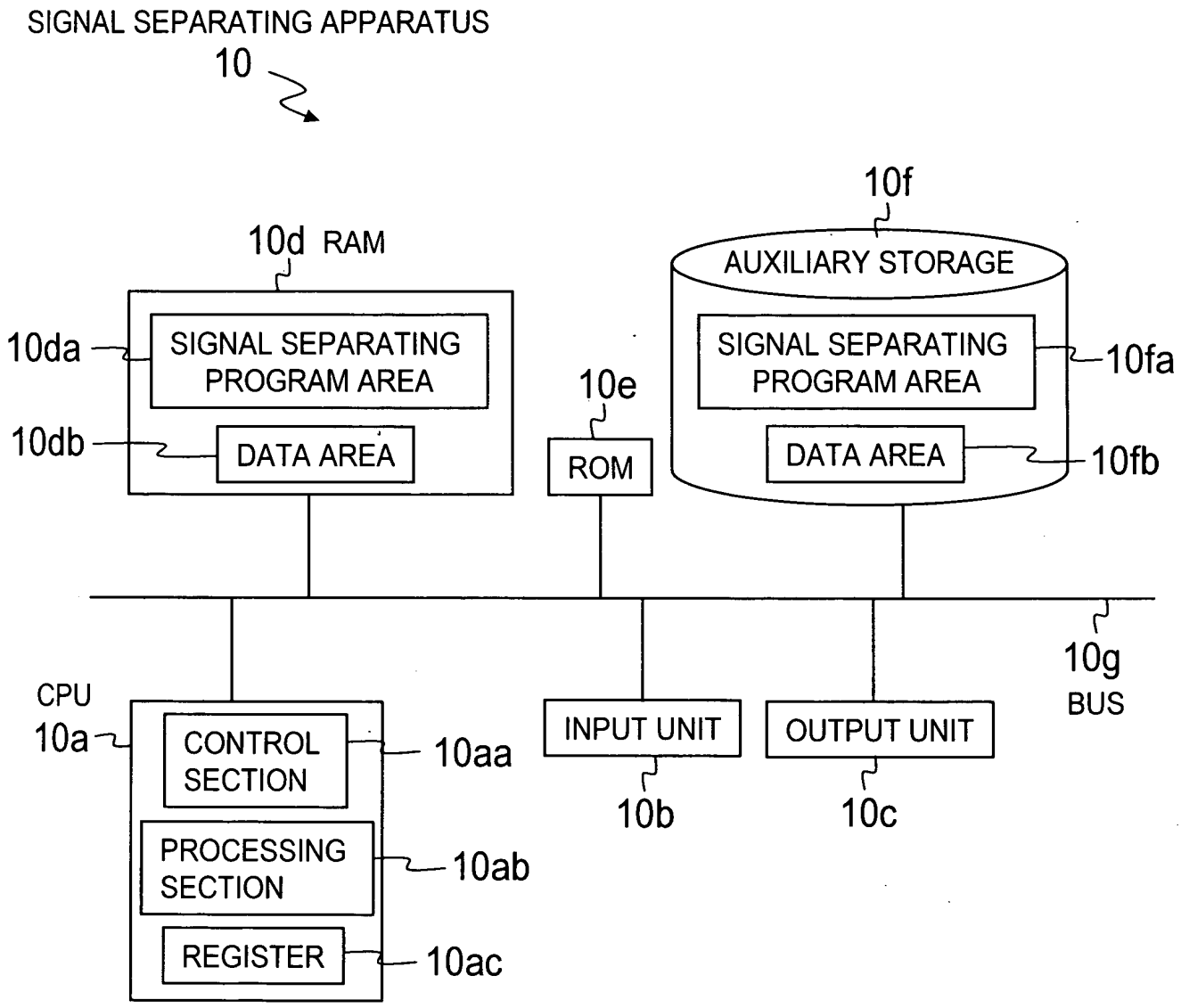

MIXED SIGNALS (IN TIME DOMAIN)
SIGNAL SEPARATING APPARATUS
1
FREQUENCY DOMAIN TRANSFORMING SECTION
2
MIXED SIGNALS (IN FREQUENCY DOMAIN)
COMPLEX VECTOR GENERATING SECTION
3
COMPLEX VECTORS
NORMALIZING SECTION
4
FREQUENCY NORMALIZATION
FIRST NORMALIZING SECTION (ARGUMENT RELATIVE VALUE NORMALIZATION)
4a
SECOND NORMALIZING SECTION (ARGUMENT FREQUENCY-COMPONENT DIVISION)
4b
THIRD NORMALIZATION SECTION (NORM NORMALIZATION)
4c
NORMALIZED VECTORS
CLUSTERING SECTION
5
CLUSTERS
SEPARATED SIGNAL GENERATING SECTION
6
SEPARATED SIGNALS (IN FREQUENCY DOMAIN)
TIME DOMAIN TRANSFORMING SECTION
7
SEPARATED SIGNALS (IN TIME DOMAIN)

FIG.2


SIGNAL SEPARATING APPARATUS
10
10f
AUXILIARY STORAGE
10d RAM
10da
SIGNAL SEPARATING PROGRAM AREA
10fa
SIGNAL SEPARATING PROGRAM AREA
10e
10db
DATA AREA
ROM
DATA AREA
10fb
10g
BUS
CPU
10a
CONTROL SECTION
10aa
INPUT UNIT
OUTPUT UNIT
10b
10c
PROCESSING SECTION
10ab
REGISTER
10ac

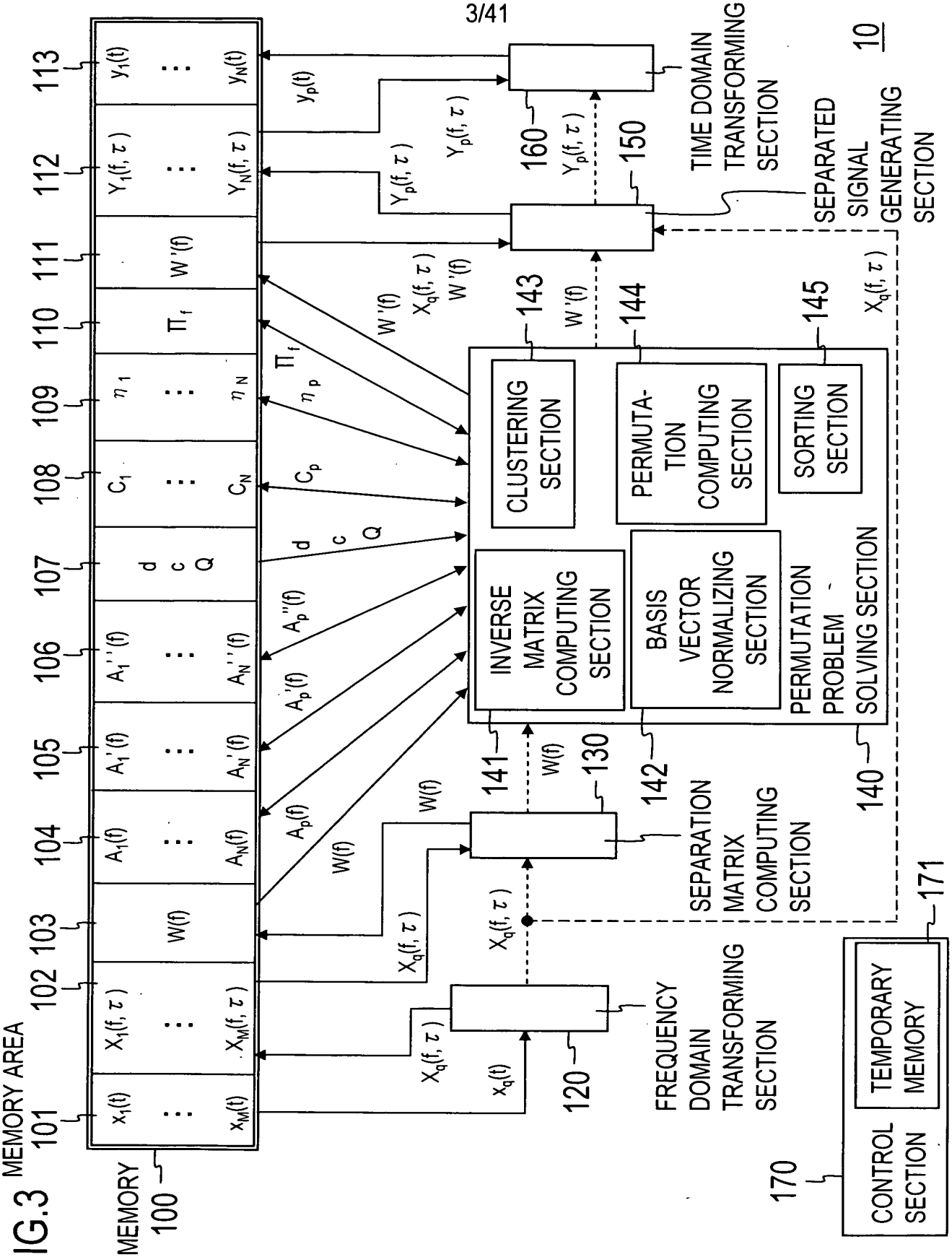

MEMORY AREA
MEMORY 100
101
102
103
104
105
106
107
108
109
110
111
112
113
$x_1(t)$
$x_M(t)$
$X_1(f,\tau)$
$X_M(f,\tau)$
W(f)
$A_1(f)$
$A_N(f)$
$A_1'(f)$
$A_N'(f)$
$A_1''(f)$
$A_N''(f)$
d
c
Q
C_1
C_N
η_1
η_N
Π_f
W'(f)
$Y_1(f,\tau)$
$Y_N(f,\tau)$
$y_1(t)$
$y_N(t)$
$x_q(t)$
120
FREQUENCY DOMAIN TRANSFORMING SECTION
$X_q(f,\tau)$
130
SEPARATION MATRIX COMPUTING SECTION
141
142
140
PERMUTATION PROBLEM SOLVING SECTION
CLUSTERING SECTION
143
INVERSE MATRIX COMPUTING SECTION
BASIS VECTOR NORMALIZING SECTION
144
PERMUTA-TION COMPUTING SECTION
145
SORTING SECTION
$Y_p(f,\tau)$
$y_p(t)$
150
160
TIME DOMAIN TRANSFORMING SECTION
SEPARATED SIGNAL GENERATING SECTION
10
170
CONTROL SECTION
171
TEMPORARY MEMORY

FIG.3

FIG.4A

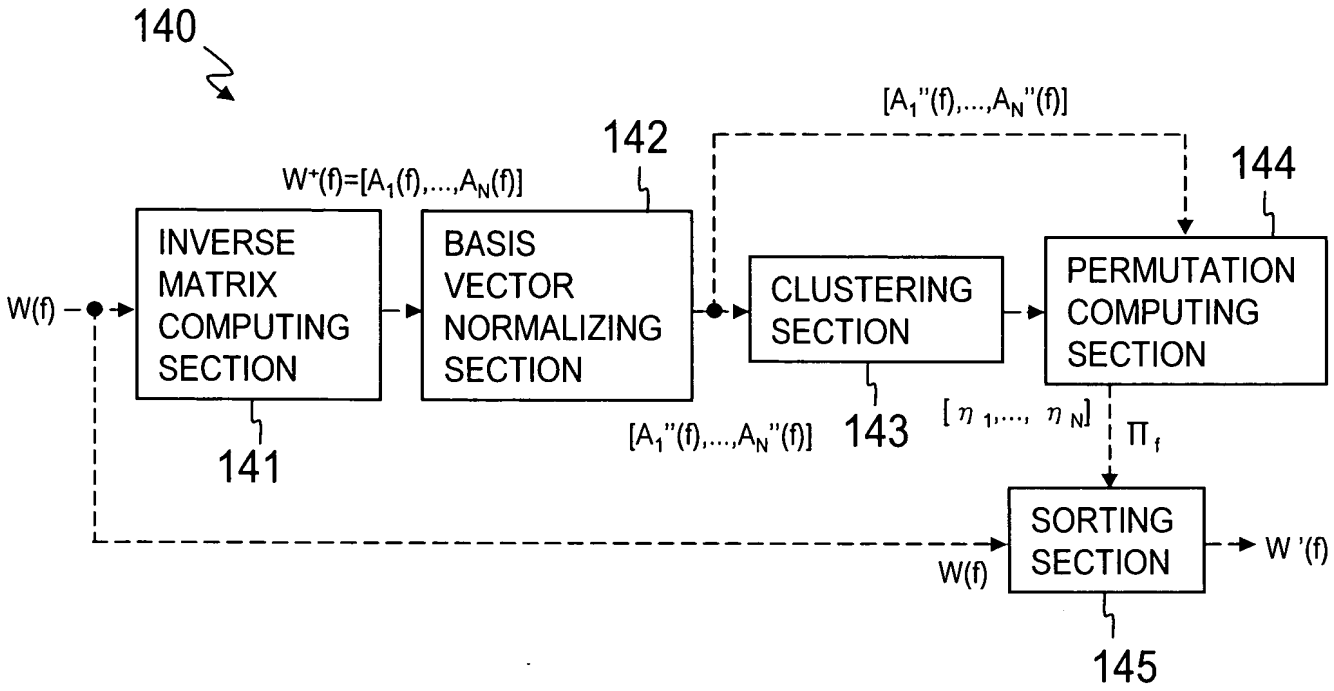
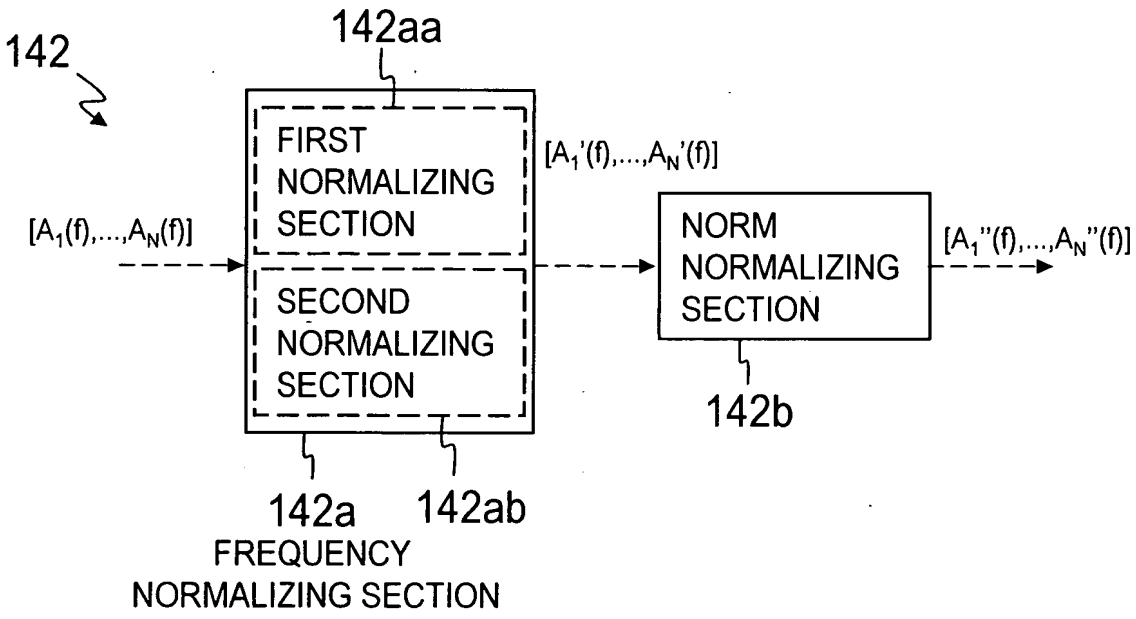

140
142
144
$W^+(f)=[A_1(f),...,A_N(f)]$
$[A_1''(f),...,A_N''(f)]$
INVERSE MATRIX COMPUTING SECTION
BASIS VECTOR NORMALIZING SECTION
CLUSTERING SECTION
PERMUTATION COMPUTING SECTION
W(f)
141
$[A_1''(f),...,A_N''(f)]$
143
$[\eta_1,...,\eta_N]$
Π_f
SORTING SECTION
W(f)
W '(f)
145

FIG.4B


142
142aa
FIRST NORMALIZING SECTION
$[A_1'(f),...,A_N'(f)]$
$[A_1(f),...,A_N(f)]$
SECOND NORMALIZING SECTION
NORM NORMALIZING SECTION
$[A_1''(f),...,A_N''(f)]$
142b
142a
142ab
FREQUENCY NORMALIZING SECTION

5/41

FIG.5

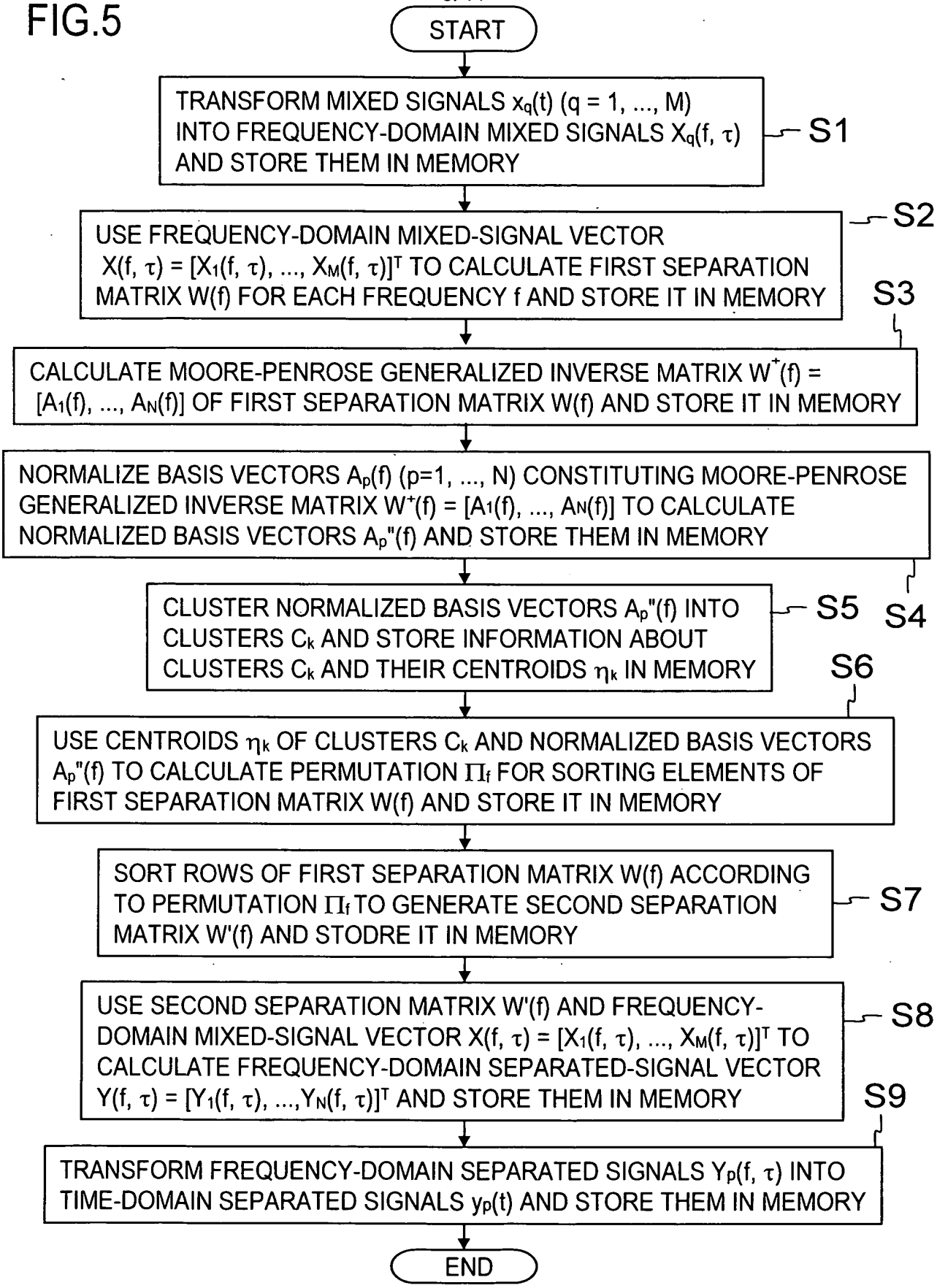

START
TRANSFORM MIXED SIGNALS $x_q(t)$ (q = 1, ..., M) INTO FREQUENCY-DOMAIN MIXED SIGNALS $X_q(f, \tau)$ AND STORE THEM IN MEMORY
S1
USE FREQUENCY-DOMAIN MIXED-SIGNAL VECTOR $X(f, \tau) = [X_1(f, \tau), ..., X_M(f, \tau)]^T$ TO CALCULATE FIRST SEPARATION MATRIX W(f) FOR EACH FREQUENCY f AND STORE IT IN MEMORY
S2
CALCULATE MOORE-PENROSE GENERALIZED INVERSE MATRIX $W^+(f) = [A_1(f), ..., A_N(f)]$ OF FIRST SEPARATION MATRIX W(f) AND STORE IT IN MEMORY
S3
NORMALIZE BASIS VECTORS $A_p(f)$ (p=1, ..., N) CONSTITUTING MOORE-PENROSE GENERALIZED INVERSE MATRIX $W^+(f) = [A_1(f), ..., A_N(f)]$ TO CALCULATE NORMALIZED BASIS VECTORS $A_p"(f)$ AND STORE THEM IN MEMORY
S4
CLUSTER NORMALIZED BASIS VECTORS $A_p"(f)$ INTO CLUSTERS C_k AND STORE INFORMATION ABOUT CLUSTERS C_k AND THEIR CENTROIDS η_k IN MEMORY
S5
USE CENTROIDS η_k OF CLUSTERS C_k AND NORMALIZED BASIS VECTORS $A_p"(f)$ TO CALCULATE PERMUTATION Π_f FOR SORTING ELEMENTS OF FIRST SEPARATION MATRIX W(f) AND STORE IT IN MEMORY
S6
SORT ROWS OF FIRST SEPARATION MATRIX W(f) ACCORDING TO PERMUTATION Π_f TO GENERATE SECOND SEPARATION MATRIX W'(f) AND STODRE IT IN MEMORY
S7
USE SECOND SEPARATION MATRIX W'(f) AND FREQUENCY-DOMAIN MIXED-SIGNAL VECTOR $X(f, \tau) = [X_1(f, \tau), ..., X_M(f, \tau)]^T$ TO CALCULATE FREQUENCY-DOMAIN SEPARATED-SIGNAL VECTOR $Y(f, \tau) = [Y_1(f, \tau), ..., Y_N(f, \tau)]^T$ AND STORE THEM IN MEMORY
S8
TRANSFORM FREQUENCY-DOMAIN SEPARATED SIGNALS $Y_p(f, \tau)$ INTO TIME-DOMAIN SEPARATED SIGNALS $y_p(t)$ AND STORE THEM IN MEMORY
S9
END

FIG.6

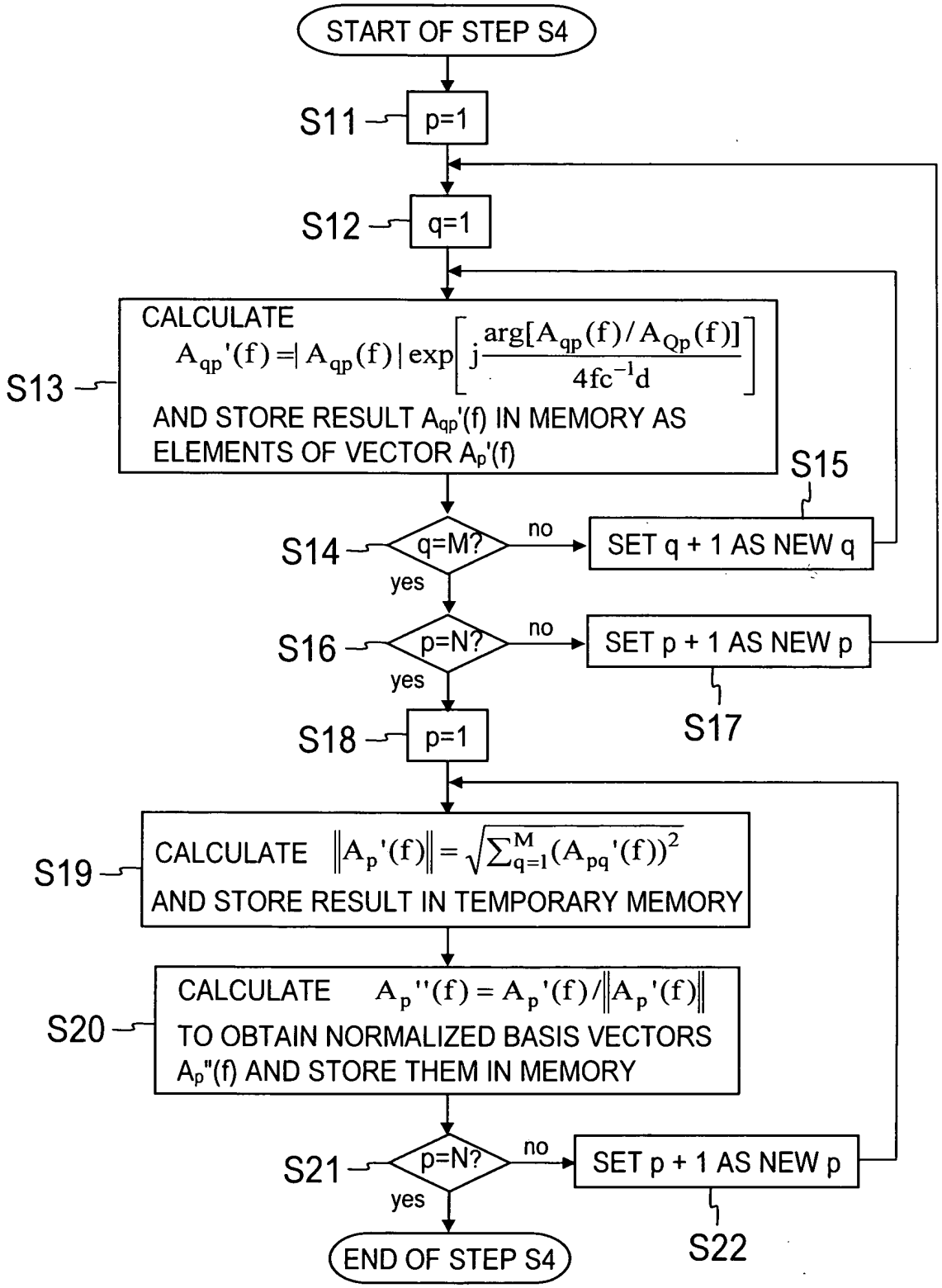

START OF STEP S4
S11
p=1
S12
q=1
S13
CALCULATE
$A_{qp}'(f) = |A_{qp}(f)| \exp\left[j \frac{\arg[A_{qp}(f)/A_{Qp}(f)]}{4fc^{-1}d} \right]$
AND STORE RESULT $A_{qp}'(f)$ IN MEMORY AS ELEMENTS OF VECTOR $A_p'(f)$
S14
q=M?
no
S15
SET q + 1 AS NEW q
yes
S16
p=N?
no
SET p + 1 AS NEW p
S17
yes
S18
p=1
S19
CALCULATE $\|A_p'(f)\| = \sqrt{\sum_{q=1}^{M} (A_{pq}'(f))^2}$
AND STORE RESULT IN TEMPORARY MEMORY
S20
CALCULATE $A_p''(f) = A_p'(f) / \|A_p'(f)\|$
TO OBTAIN NORMALIZED BASIS VECTORS $A_p''(f)$ AND STORE THEM IN MEMORY
S21
p=N?
no
SET p + 1 AS NEW p
S22
yes
END OF STEP S4

FIG.7A

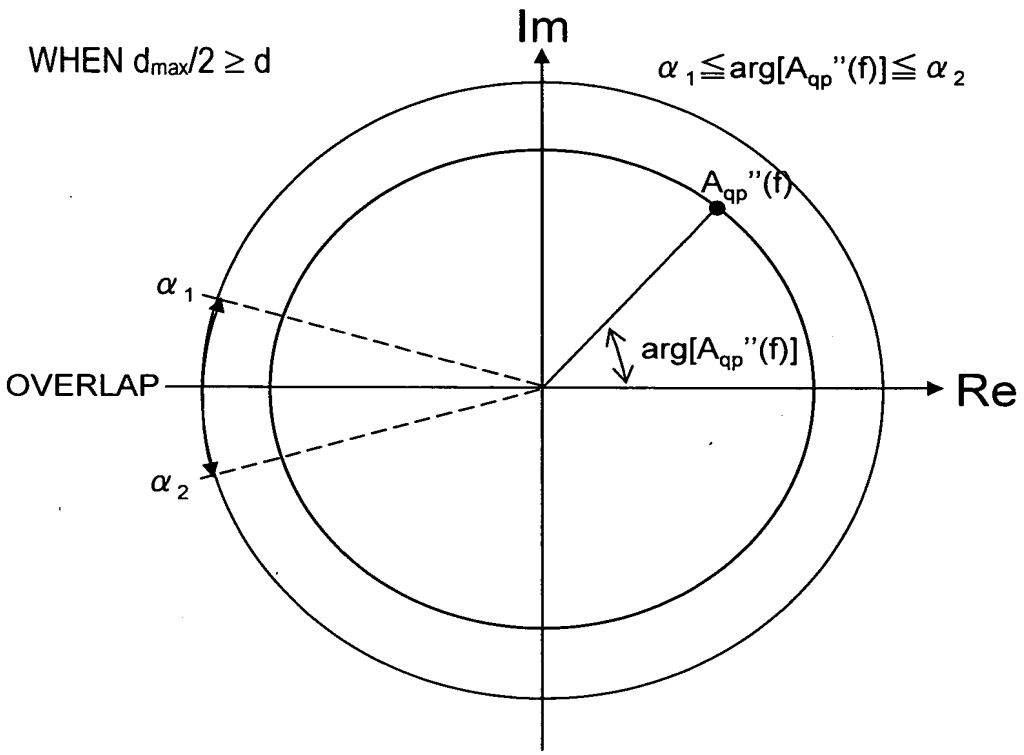

WHEN $d_{max}/2 \geq d$
Im
$\alpha_1 \leqq \arg[A_{qp}''(f)] \leqq \alpha_2$
$A_{qp}''(f)$
α_1
$\arg[A_{qp}''(f)]$
OVERLAP
Re
α_2

FIG.7B

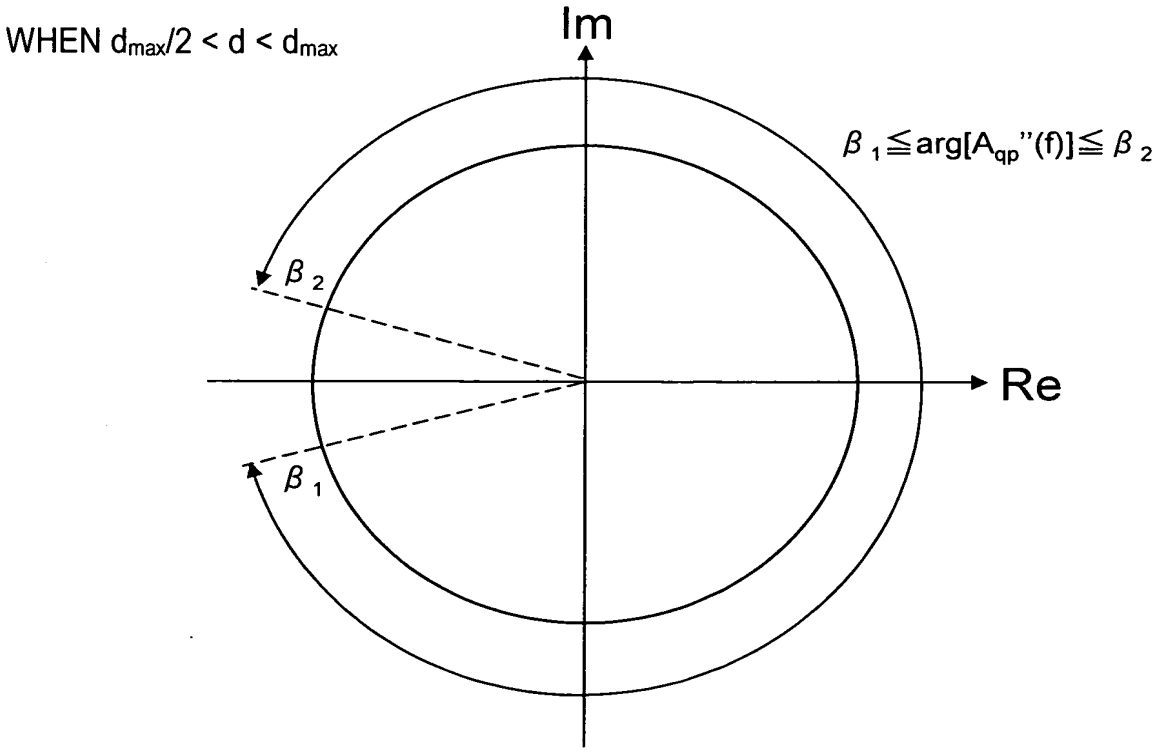

WHEN $d_{max}/2 < d < d_{max}$
Im
$\beta_1 \leqq \arg[A_{qp}''(f)] \leqq \beta_2$
β_2
Re
β_1

FIG.8A

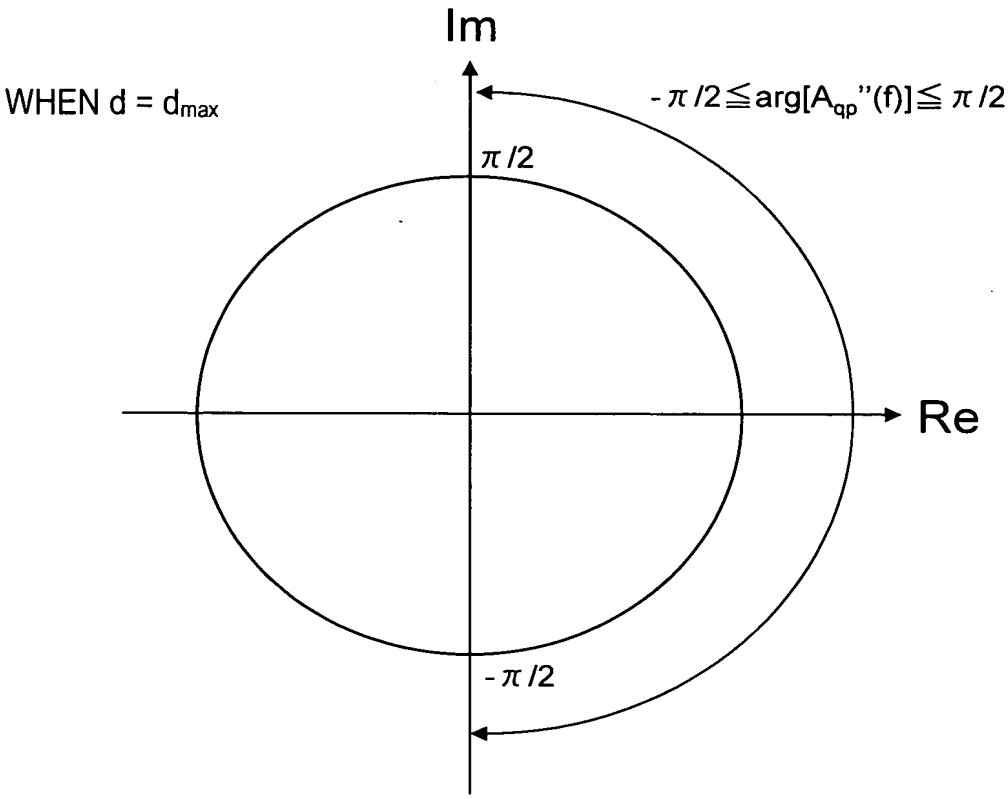
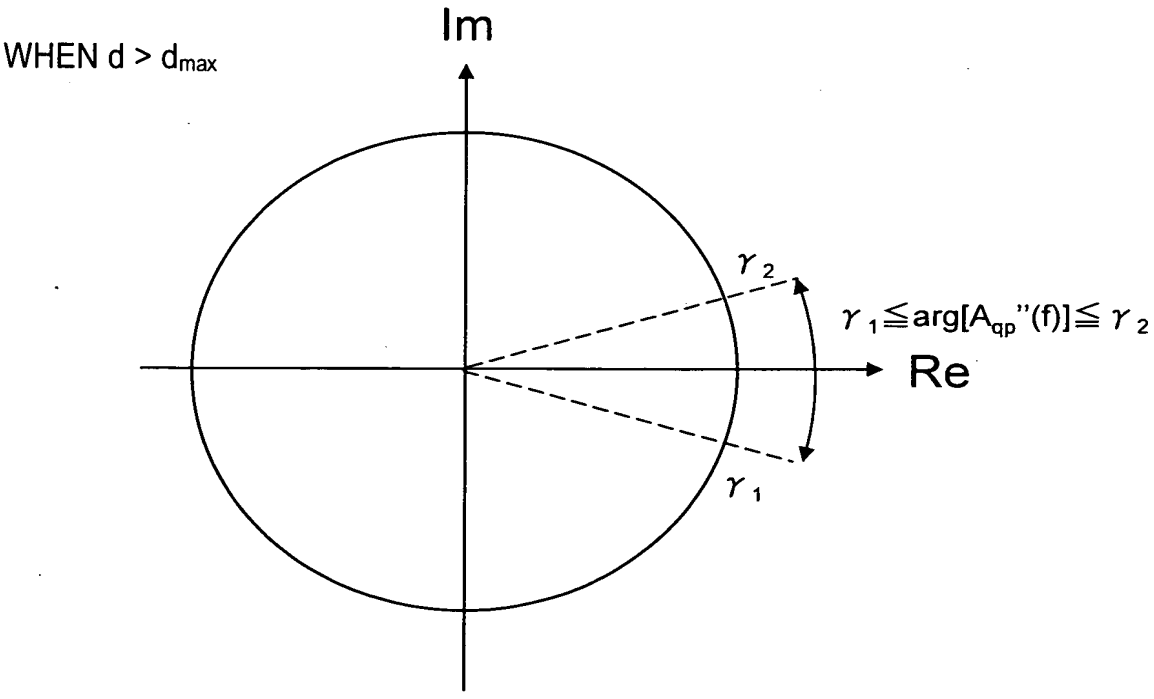

Im
WHEN d = d_{max}
$-\pi/2 \leqq \arg[A_{qp}''(f)] \leqq \pi/2$
$\pi/2$
Re
$-\pi/2$

FIG.8B


Im
WHEN d > d_{max}
γ_2
$\gamma_1 \leqq \arg[A_{qp}''(f)] \leqq \gamma_2$
Re
γ_1

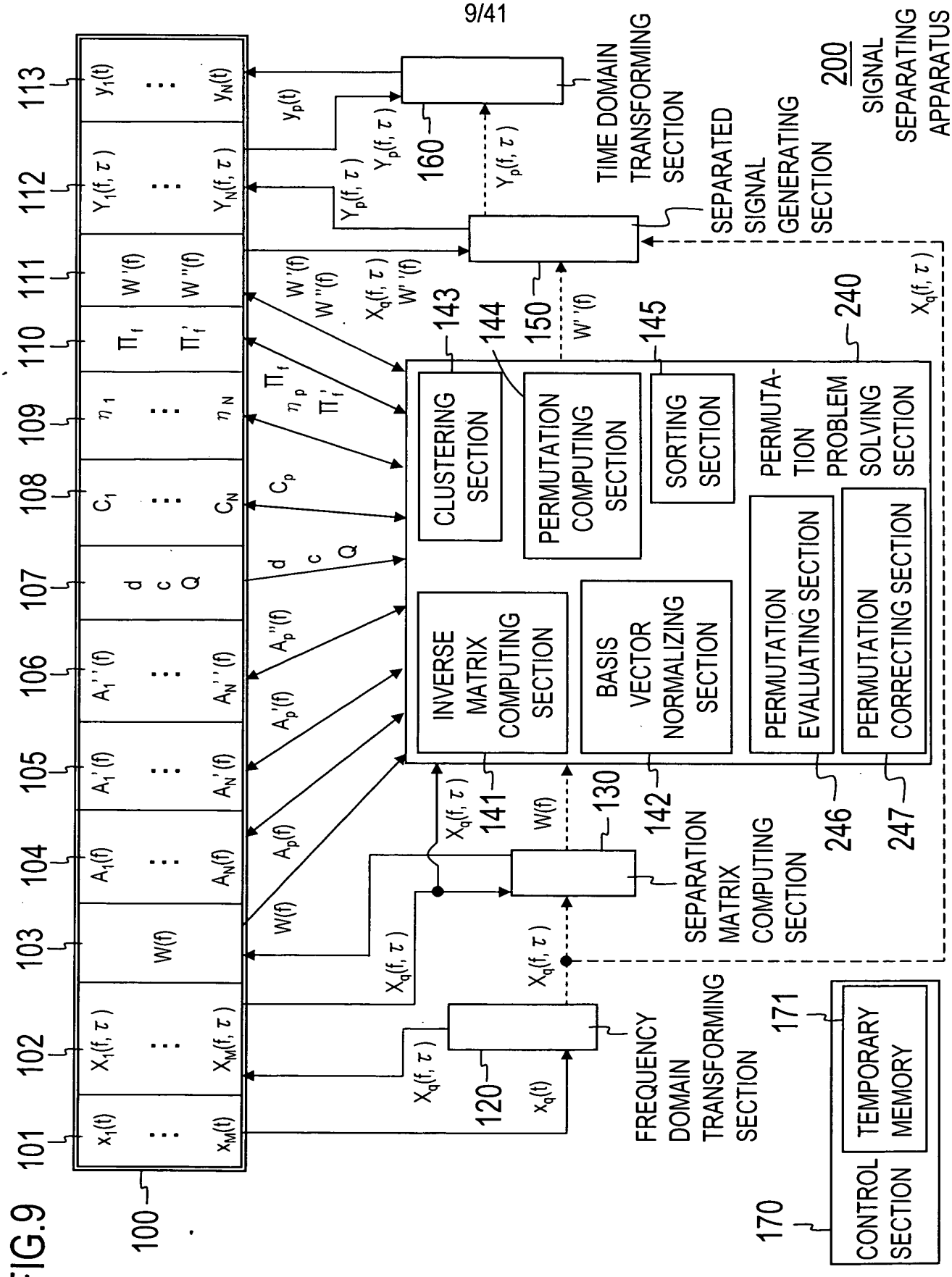

100
101
102
103
104
105
106
107
108
109
110
111
112
113
120
130
141
142
143
144
145
150
160
170
171
200
240
246
247
SIGNAL SEPARATING APPARATUS
SEPARATED SIGNAL GENERATING SECTION
TIME DOMAIN TRANSFORMING SECTION
FREQUENCY DOMAIN TRANSFORMING SECTION
SEPARATION MATRIX COMPUTING SECTION
CLUSTERING SECTION
PERMUTATION COMPUTING SECTION
SORTING SECTION
PERMUTATION PROBLEM SOLVING SECTION
PERMUTATION EVALUATING SECTION
PERMUTATION CORRECTING SECTION
INVERSE MATRIX COMPUTING SECTION
BASIS VECTOR NORMALIZING SECTION
CONTROL SECTION
TEMPORARY MEMORY

FIG.9

FIG.10A

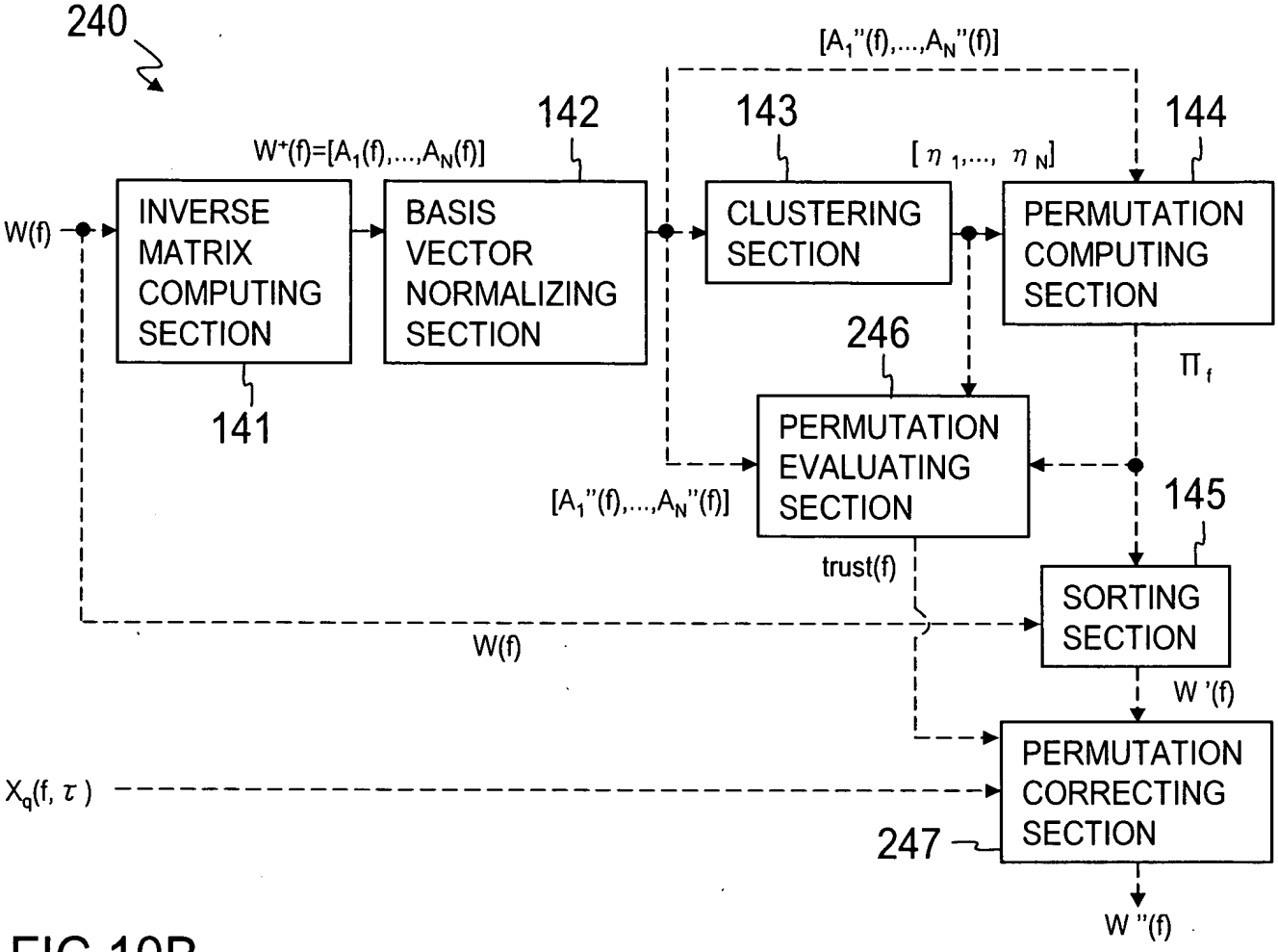


FIG.10B

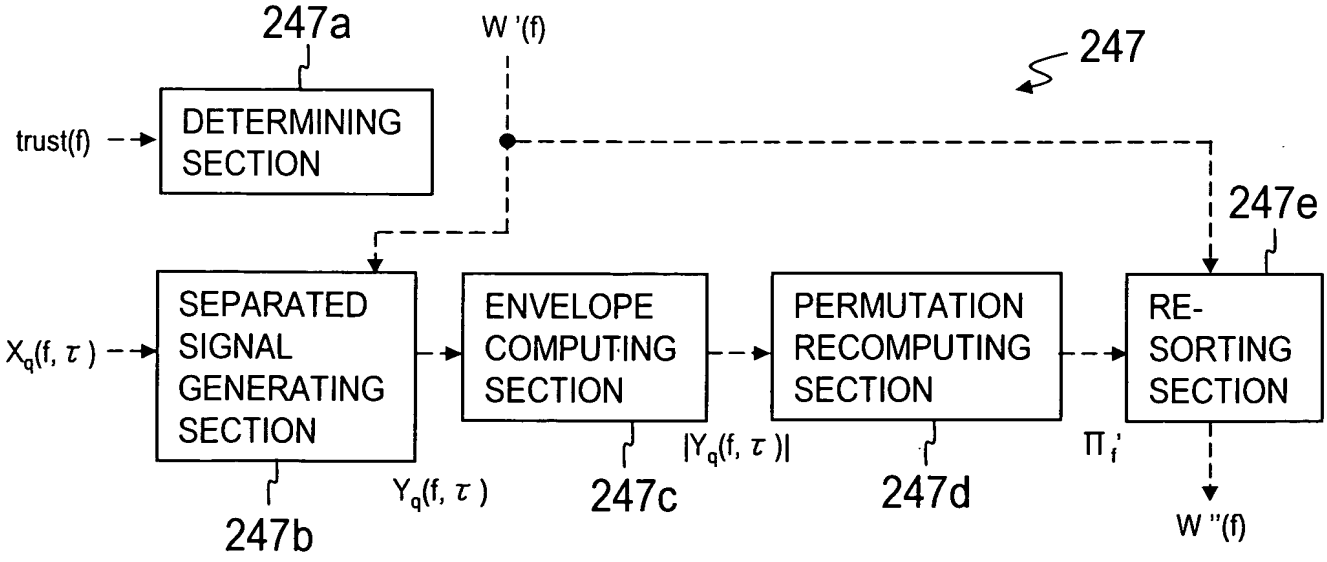


FIG.11

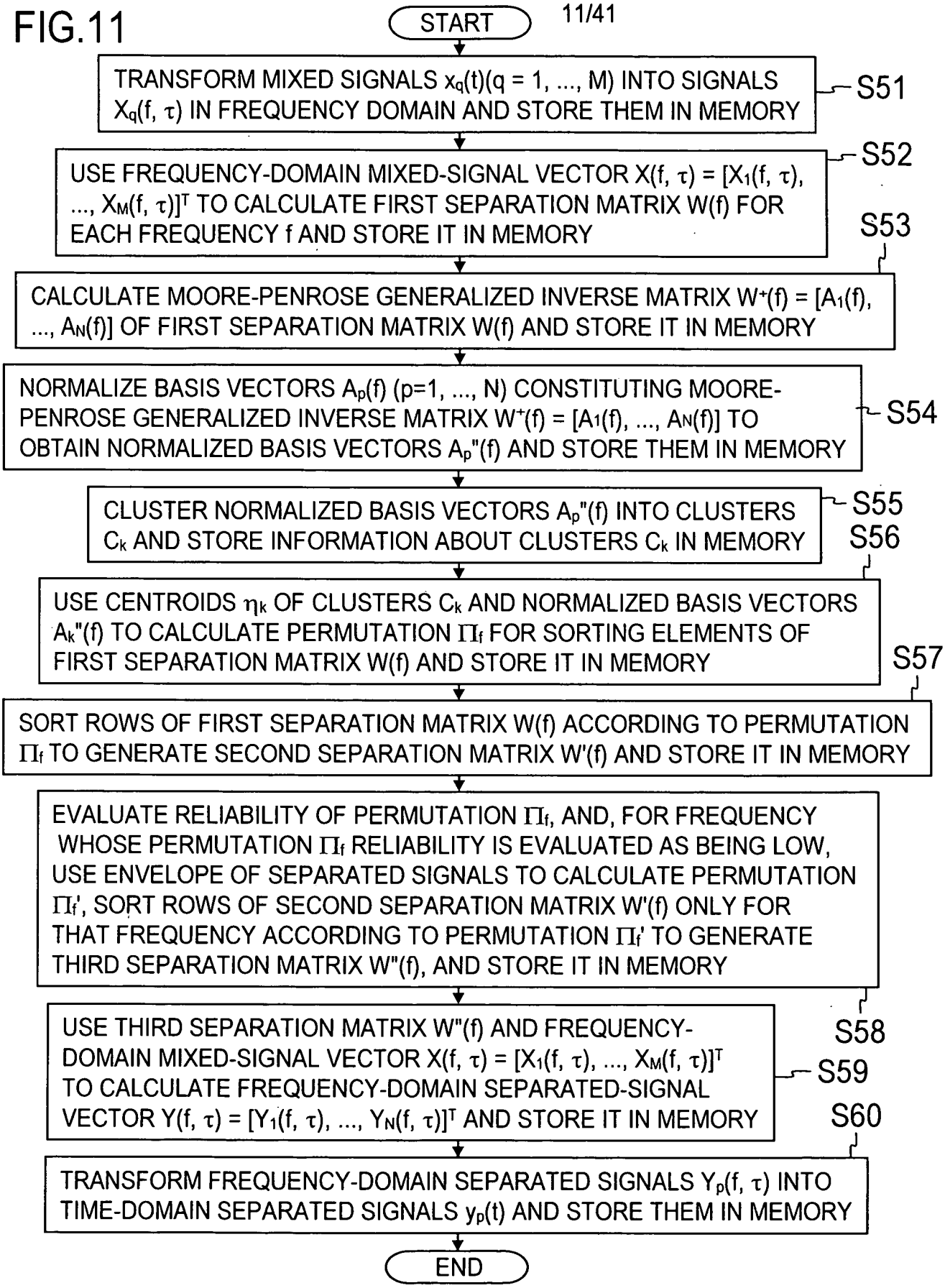

START
TRANSFORM MIXED SIGNALS $x_q(t)(q = 1, ..., M)$ INTO SIGNALS $X_q(f, \tau)$ IN FREQUENCY DOMAIN AND STORE THEM IN MEMORY
S51
USE FREQUENCY-DOMAIN MIXED-SIGNAL VECTOR $X(f, \tau) = [X_1(f, \tau), ..., X_M(f, \tau)]^T$ TO CALCULATE FIRST SEPARATION MATRIX W(f) FOR EACH FREQUENCY f AND STORE IT IN MEMORY
S52
CALCULATE MOORE-PENROSE GENERALIZED INVERSE MATRIX $W^+(f) = [A_1(f), ..., A_N(f)]$ OF FIRST SEPARATION MATRIX W(f) AND STORE IT IN MEMORY
S53
NORMALIZE BASIS VECTORS $A_p(f)$ (p=1, ..., N) CONSTITUTING MOORE-PENROSE GENERALIZED INVERSE MATRIX $W^+(f) = [A_1(f), ..., A_N(f)]$ TO OBTAIN NORMALIZED BASIS VECTORS $A_p"(f)$ AND STORE THEM IN MEMORY
S54
CLUSTER NORMALIZED BASIS VECTORS $A_p"(f)$ INTO CLUSTERS C_k AND STORE INFORMATION ABOUT CLUSTERS C_k IN MEMORY
S55
USE CENTROIDS η_k OF CLUSTERS C_k AND NORMALIZED BASIS VECTORS $A_k"(f)$ TO CALCULATE PERMUTATION Π_f FOR SORTING ELEMENTS OF FIRST SEPARATION MATRIX W(f) AND STORE IT IN MEMORY
S56
SORT ROWS OF FIRST SEPARATION MATRIX W(f) ACCORDING TO PERMUTATION Π_f TO GENERATE SECOND SEPARATION MATRIX W'(f) AND STORE IT IN MEMORY
S57
EVALUATE RELIABILITY OF PERMUTATION Π_f, AND, FOR FREQUENCY WHOSE PERMUTATION Π_f RELIABILITY IS EVALUATED AS BEING LOW, USE ENVELOPE OF SEPARATED SIGNALS TO CALCULATE PERMUTATION Π_f', SORT ROWS OF SECOND SEPARATION MATRIX W'(f) ONLY FOR THAT FREQUENCY ACCORDING TO PERMUTATION Π_f' TO GENERATE THIRD SEPARATION MATRIX W"(f), AND STORE IT IN MEMORY
S58
USE THIRD SEPARATION MATRIX W"(f) AND FREQUENCY-DOMAIN MIXED-SIGNAL VECTOR $X(f, \tau) = [X_1(f, \tau), ..., X_M(f, \tau)]^T$ TO CALCULATE FREQUENCY-DOMAIN SEPARATED-SIGNAL VECTOR $Y(f, \tau) = [Y_1(f, \tau), ..., Y_N(f, \tau)]^T$ AND STORE IT IN MEMORY
S59
TRANSFORM FREQUENCY-DOMAIN SEPARATED SIGNALS $Y_p(f, \tau)$ INTO TIME-DOMAIN SEPARATED SIGNALS $y_p(t)$ AND STORE THEM IN MEMORY
S60
END

FIG.12

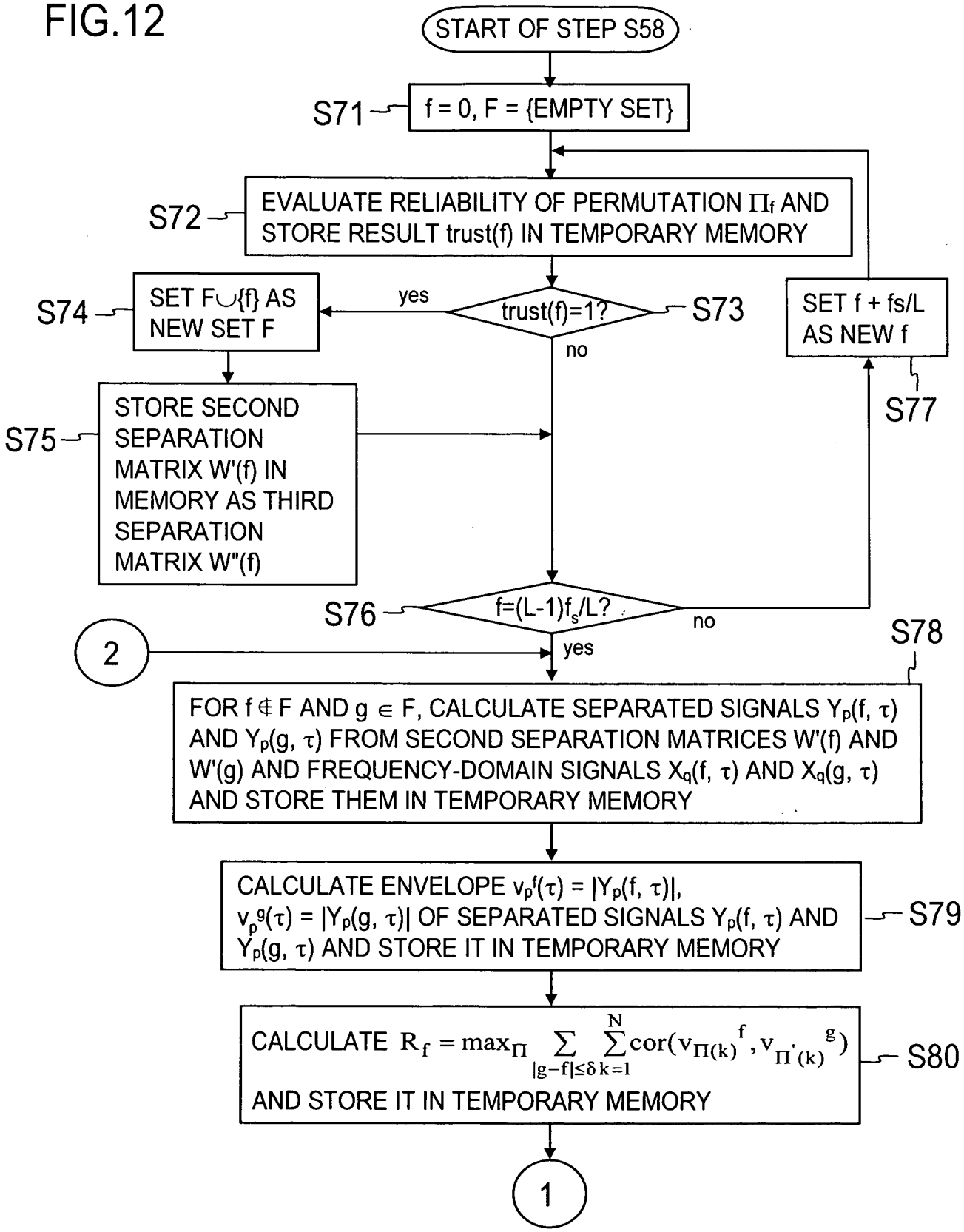

START OF STEP S58
S71
f = 0, F = {EMPTY SET}
S72
EVALUATE RELIABILITY OF PERMUTATION Πf AND STORE RESULT trust(f) IN TEMPORARY MEMORY
S74
SET F∪{f} AS NEW SET F
yes
trust(f)=1?
S73
no
SET f + fs/L AS NEW f
S77
S75
STORE SECOND SEPARATION MATRIX W'(f) IN MEMORY AS THIRD SEPARATION MATRIX W"(f)
S76
f=(L-1)fs/L?
no
yes
2
S78
FOR f ∉ F AND g ∈ F, CALCULATE SEPARATED SIGNALS Yp(f, τ) AND Yp(g, τ) FROM SECOND SEPARATION MATRICES W'(f) AND W'(g) AND FREQUENCY-DOMAIN SIGNALS Xq(f, τ) AND Xq(g, τ) AND STORE THEM IN TEMPORARY MEMORY
CALCULATE ENVELOPE vp^f(τ) = |Yp(f, τ)|, vp^g(τ) = |Yp(g, τ)| OF SEPARATED SIGNALS Yp(f, τ) AND Yp(g, τ) AND STORE IT IN TEMPORARY MEMORY
S79
CALCULATE $R_f = \max_{\Pi} \sum_{|g-f|\le\delta} \sum_{k=1}^{N} \mathrm{cor}(v_{\Pi(k)}{}^{f}, v_{\Pi'(k)}{}^{g})$
AND STORE IT IN TEMPORARY MEMORY
S80
1

FIG.13

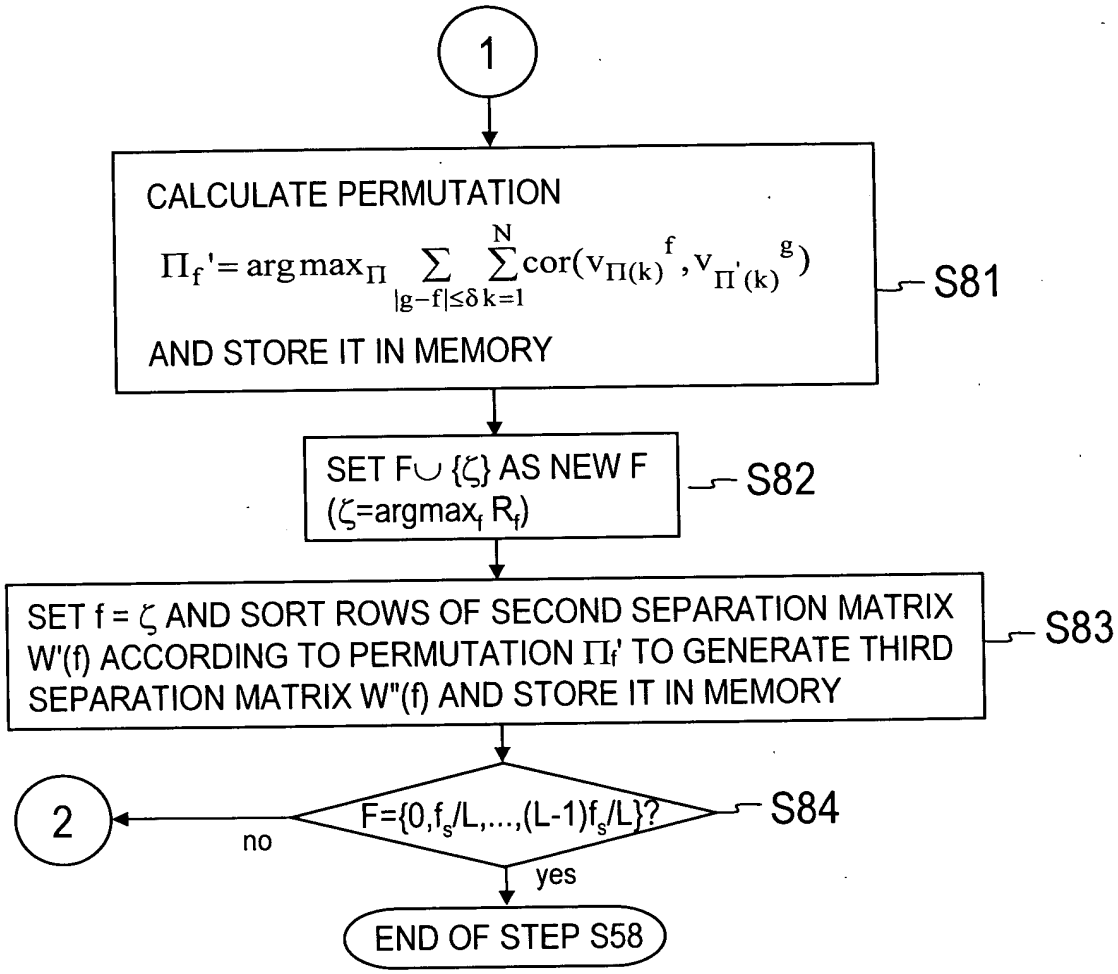

1
CALCULATE PERMUTATION
$\Pi_f' = \arg\max_{\Pi} \sum_{|g-f|\le\delta} \sum_{k=1}^{N} \mathrm{cor}(v_{\Pi(k)}^{f}, v_{\Pi'(k)}^{g})$
AND STORE IT IN MEMORY
S81
SET F∪{ζ} AS NEW F
(ζ=argmax$_f$ R$_f$)
S82
SET f = ζ AND SORT ROWS OF SECOND SEPARATION MATRIX W'(f) ACCORDING TO PERMUTATION Πf' TO GENERATE THIRD SEPARATION MATRIX W"(f) AND STORE IT IN MEMORY
S83
F={0,f$_s$/L,...,(L-1)f$_s$/L}?
S84
no
2
yes
END OF STEP S58

FIG.14A

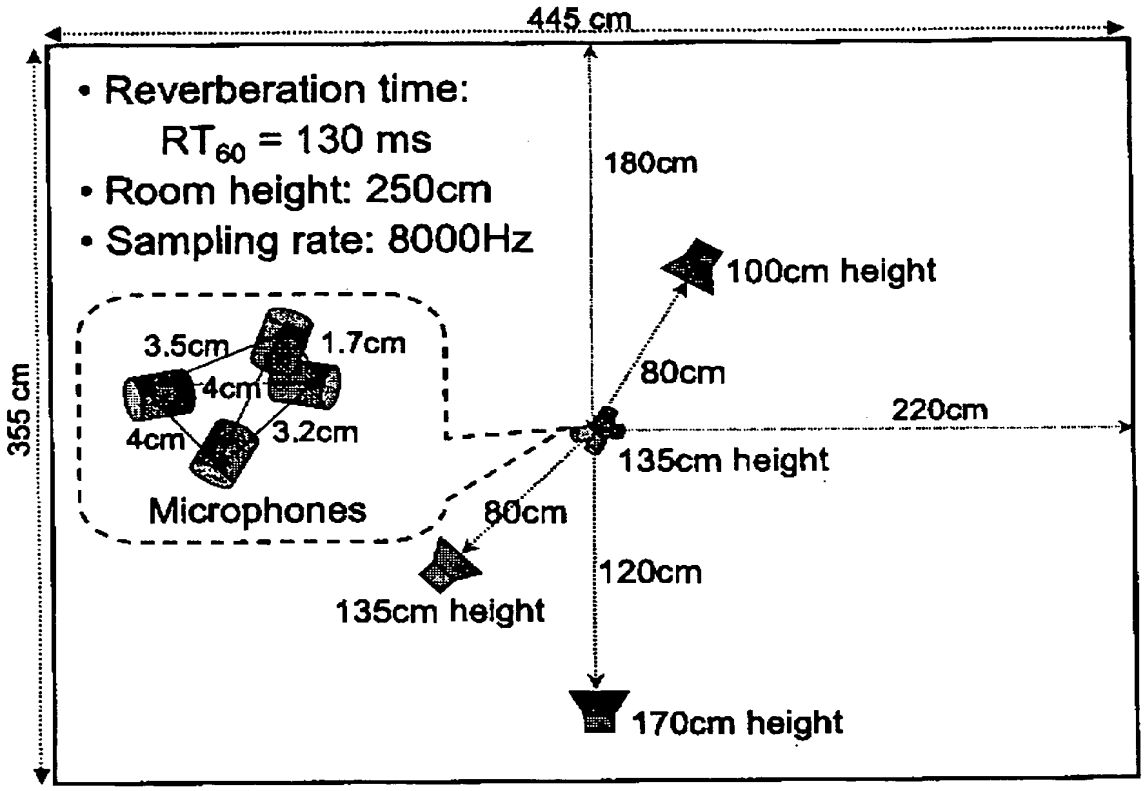


FIG.14B

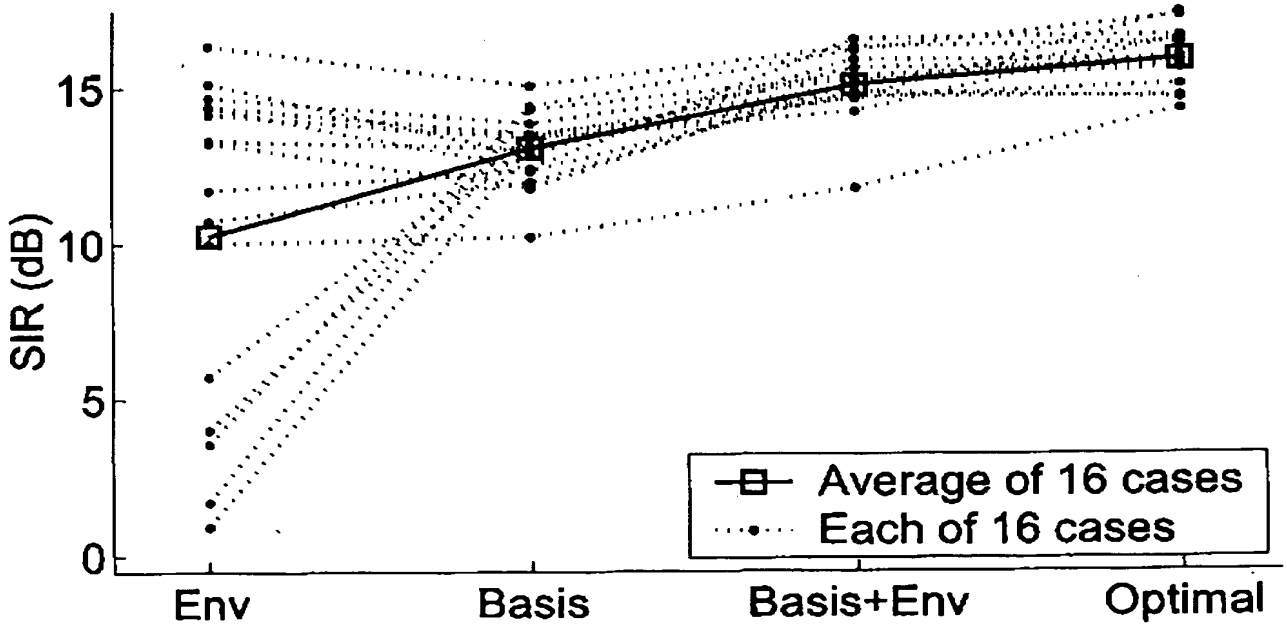


FIG.15A

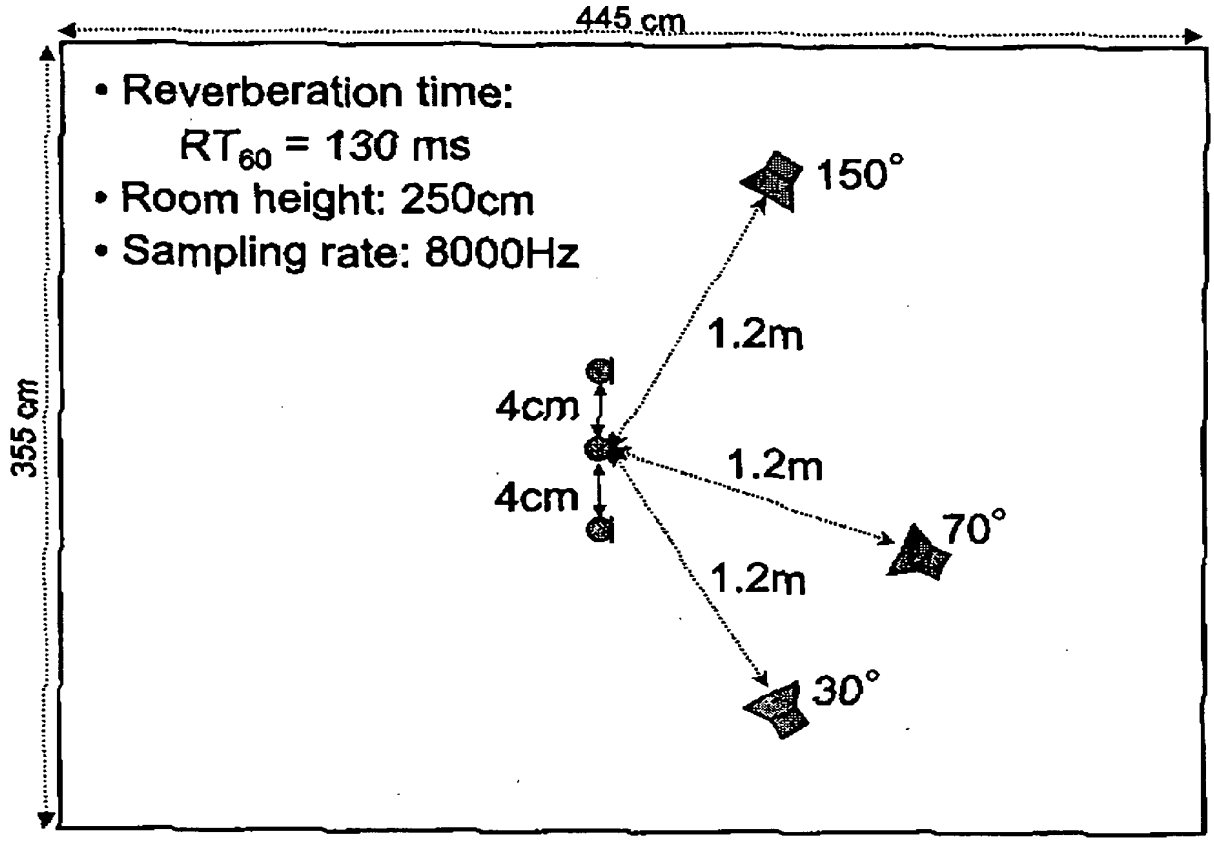


FIG.15B

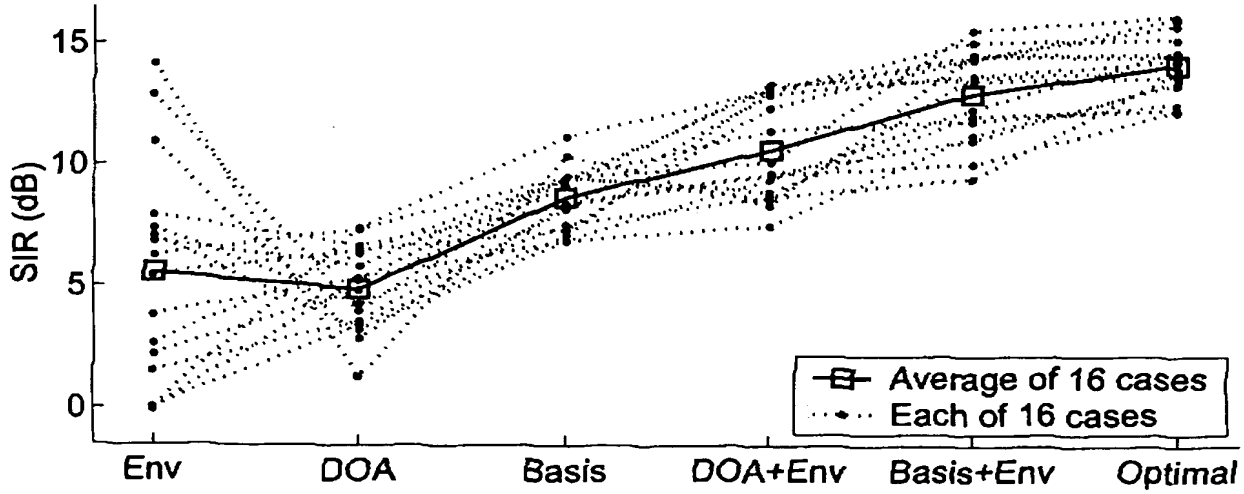


FIG.16

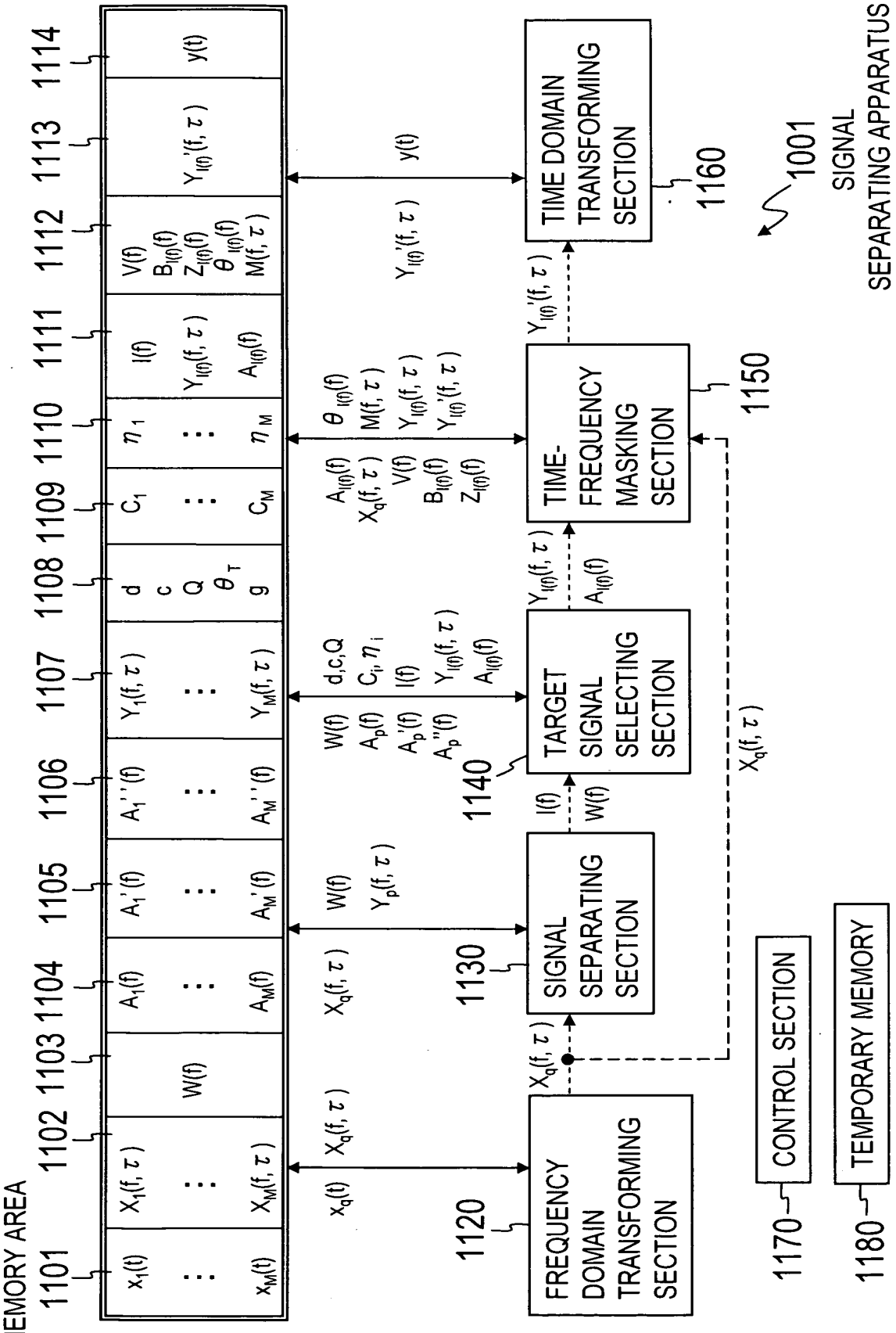

1100 MEMORY
MEMORY AREA
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
$x_1(t)$
$x_M(t)$
$X_1(f,\tau)$
$X_M(f,\tau)$
W(f)
$A_1(f)$
$A_M(f)$
$A_1'(f)$
$A_M'(f)$
$A_1''(f)$
$A_M''(f)$
$Y_1(f,\tau)$
$Y_M(f,\tau)$
d
c
Q
θ_T
g
C_1
C_M
η_1
η_M
I(f)
$Y_{I(f)}(f,\tau)$
$A_{I(f)}(f)$
V(f)
$B_{I(f)}(f)$
$Z_{I(f)}(f)$
$\theta_{I(f)}(f)$
$M(f,\tau)$
$Y_{I(f)}'(f,\tau)$
y(t)
$x_q(t)$
$X_q(f,\tau)$
$X_p(f,\tau)$
$A_p(f)$
$A_p'(f)$
$A_p''(f)$
C_i, η_i
1120
FREQUENCY DOMAIN TRANSFORMING SECTION
1130
SIGNAL SEPARATING SECTION
1140
TARGET SIGNAL SELECTING SECTION
1150
TIME-FREQUENCY MASKING SECTION
1160
TIME DOMAIN TRANSFORMING SECTION
1170
CONTROL SECTION
1180
TEMPORARY MEMORY
1001
SIGNAL SEPARATING APPARATUS

FIG.17A

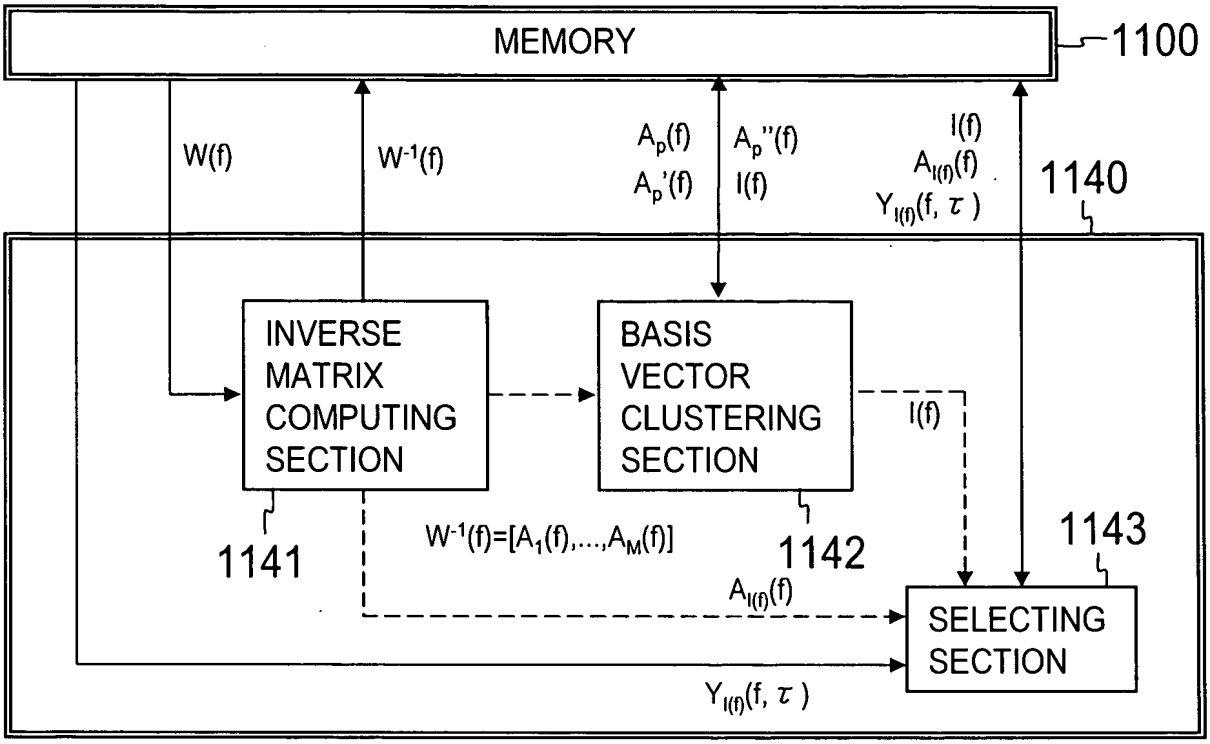


FIG.17B

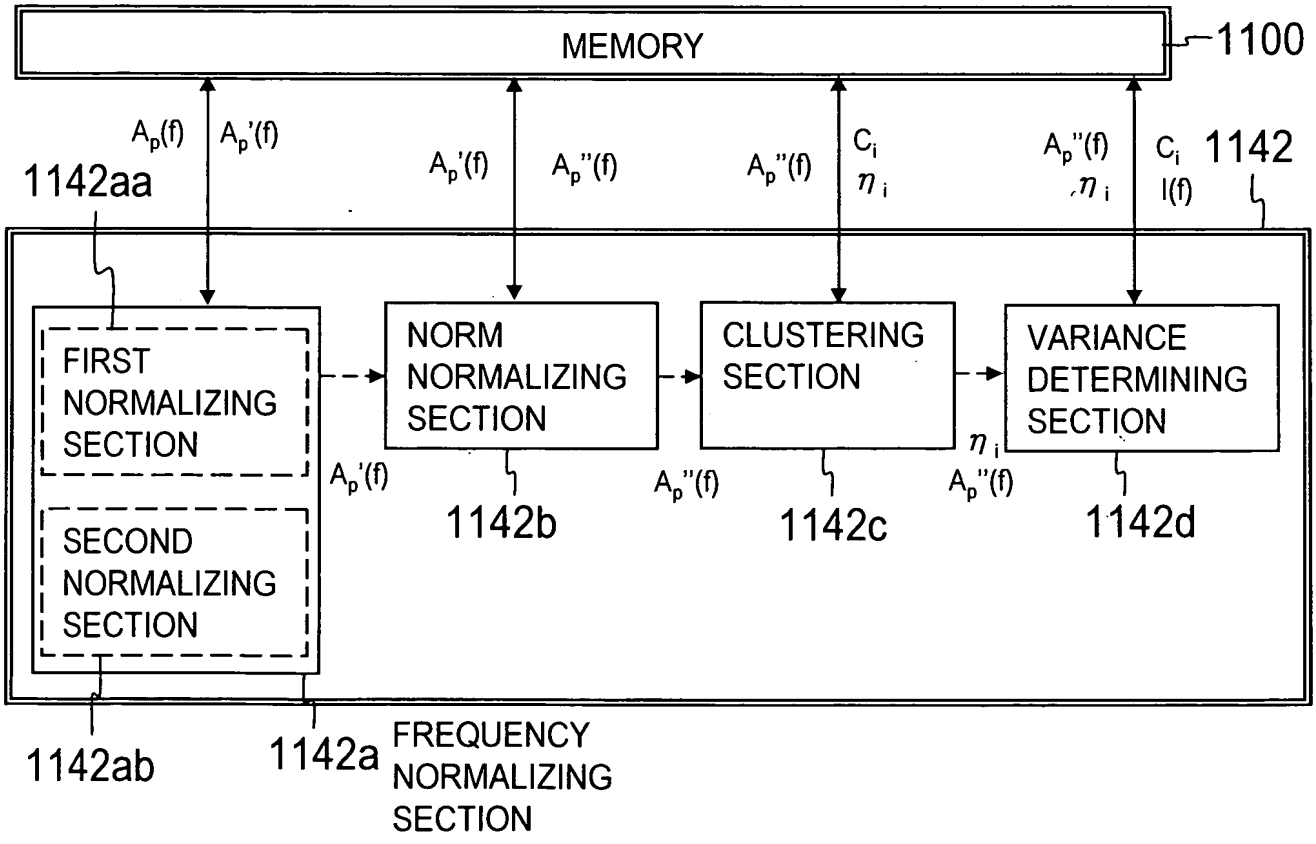


FIG.18A

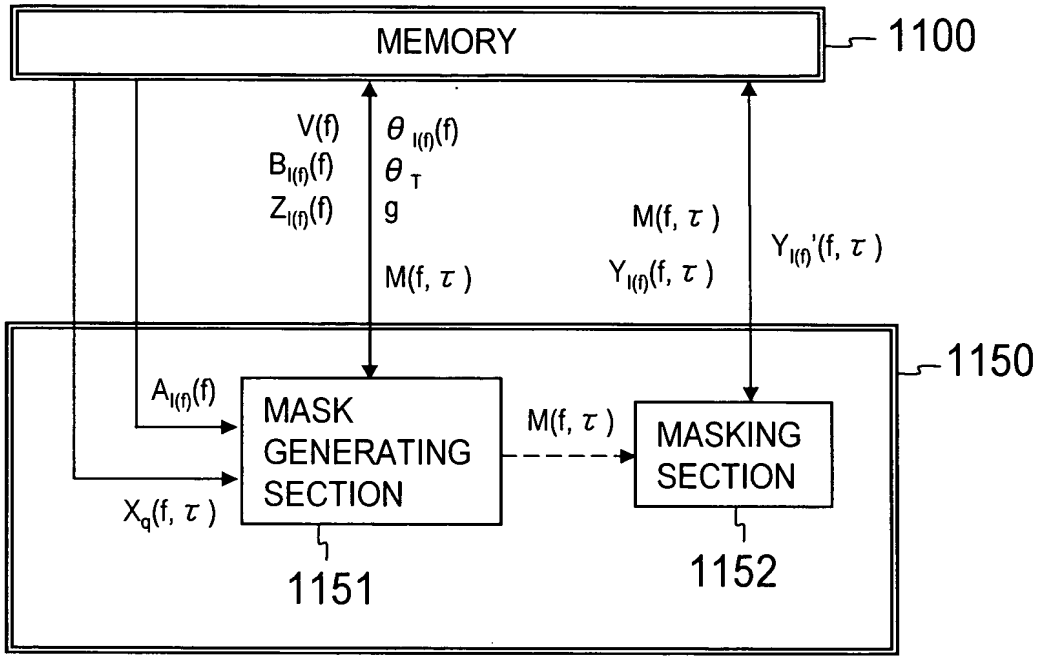


FIG.18B

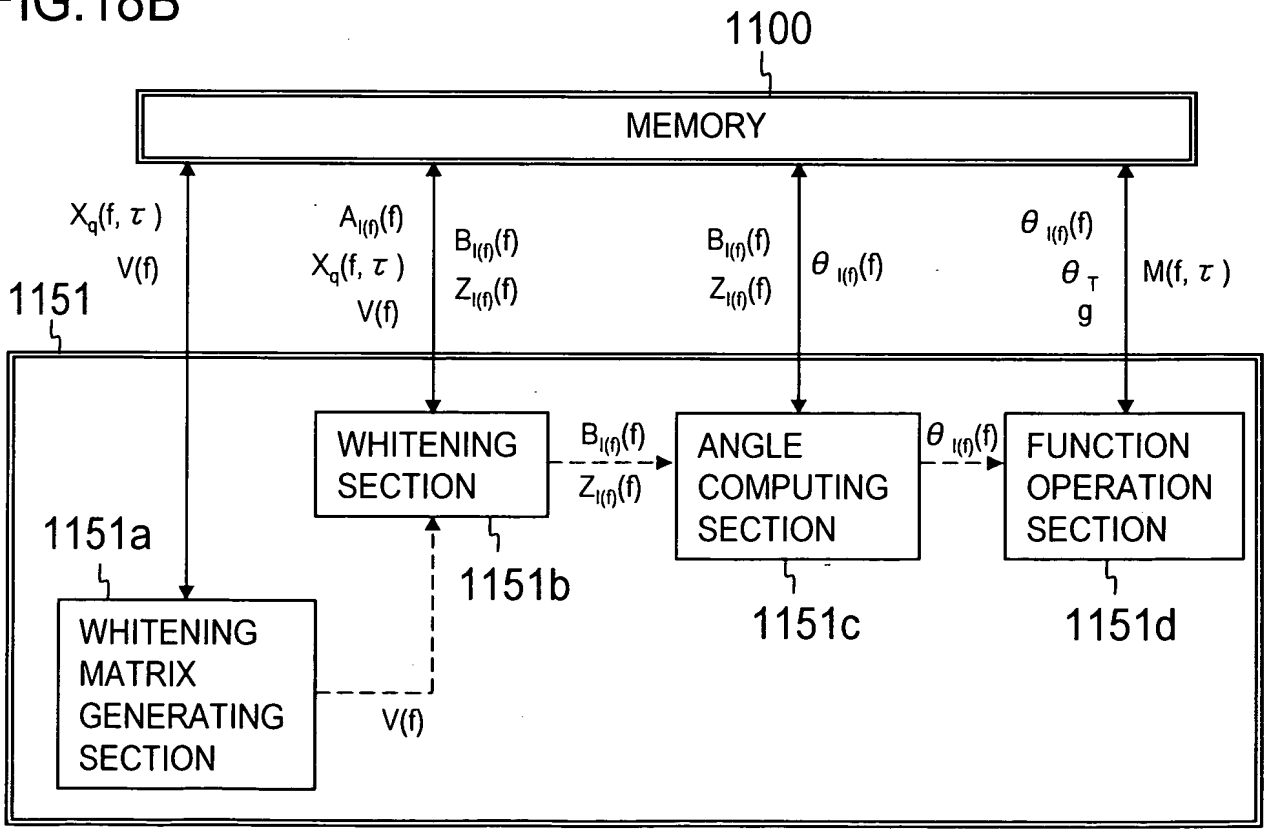


FIG.19

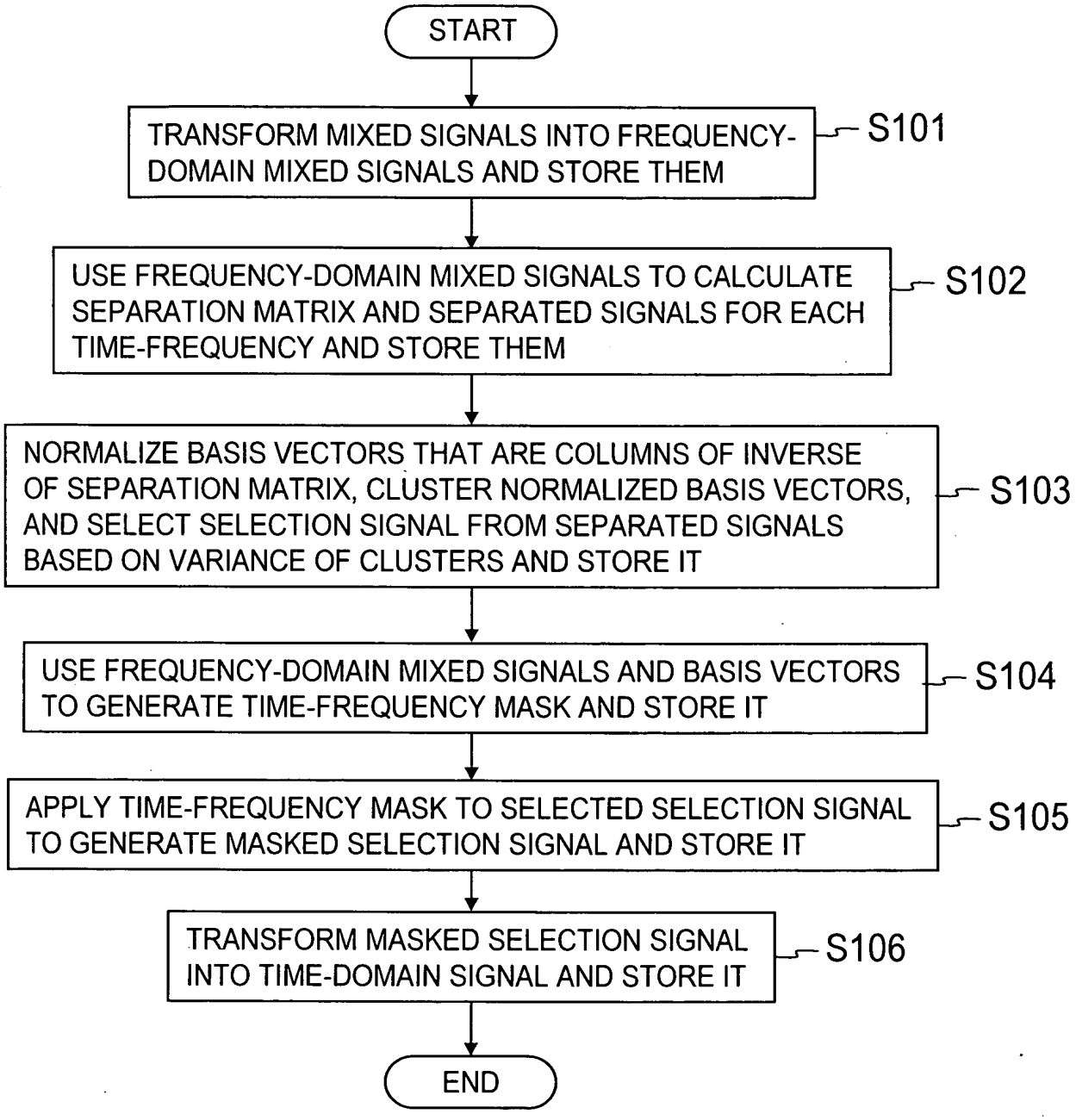

START
TRANSFORM MIXED SIGNALS INTO FREQUENCY-DOMAIN MIXED SIGNALS AND STORE THEM
S101
USE FREQUENCY-DOMAIN MIXED SIGNALS TO CALCULATE SEPARATION MATRIX AND SEPARATED SIGNALS FOR EACH TIME-FREQUENCY AND STORE THEM
S102
NORMALIZE BASIS VECTORS THAT ARE COLUMNS OF INVERSE OF SEPARATION MATRIX, CLUSTER NORMALIZED BASIS VECTORS, AND SELECT SELECTION SIGNAL FROM SEPARATED SIGNALS BASED ON VARIANCE OF CLUSTERS AND STORE IT
S103
USE FREQUENCY-DOMAIN MIXED SIGNALS AND BASIS VECTORS TO GENERATE TIME-FREQUENCY MASK AND STORE IT
S104
APPLY TIME-FREQUENCY MASK TO SELECTED SELECTION SIGNAL TO GENERATE MASKED SELECTION SIGNAL AND STORE IT
S105
TRANSFORM MASKED SELECTION SIGNAL INTO TIME-DOMAIN SIGNAL AND STORE IT
S106
END

FIG.20

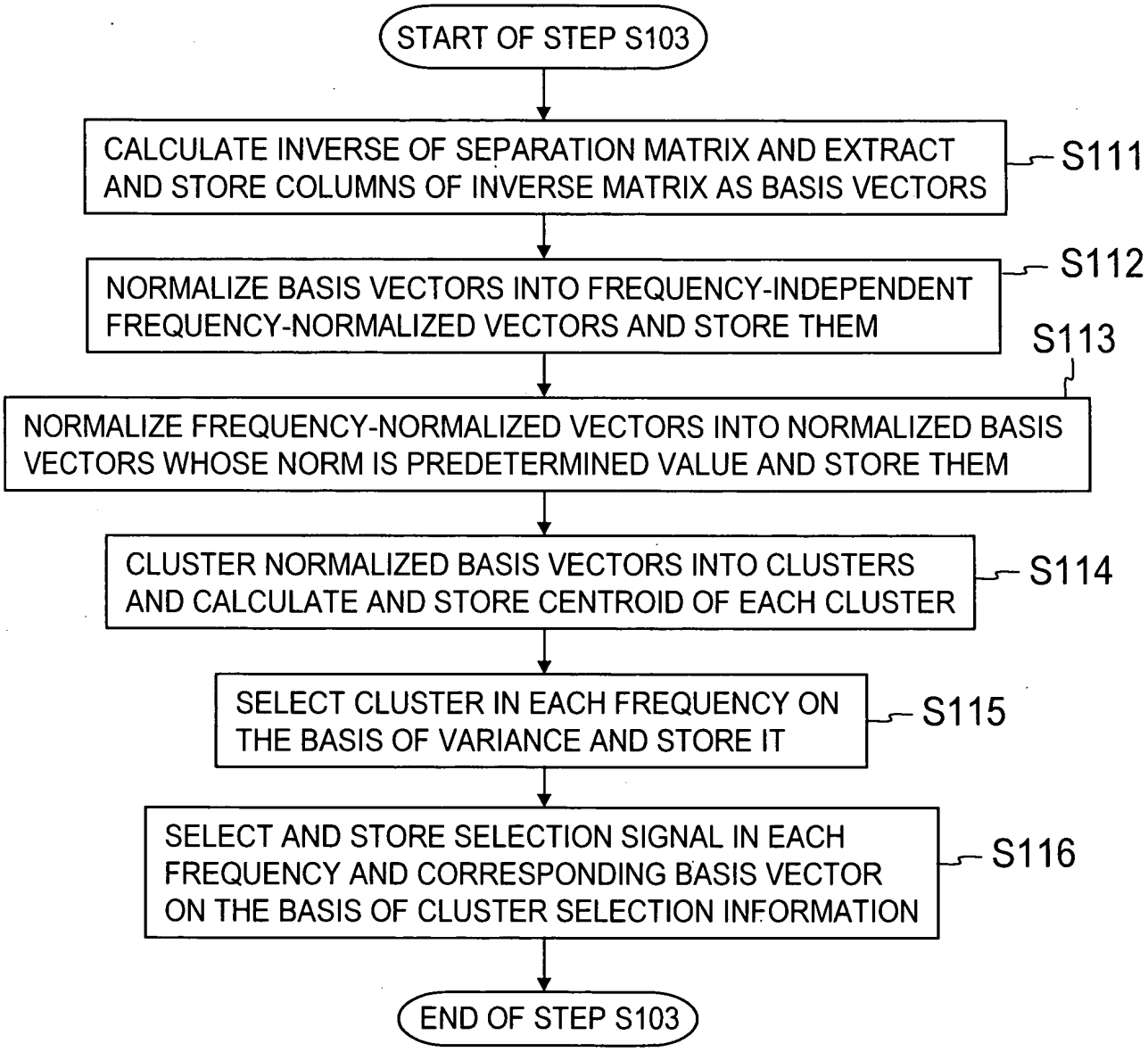

START OF STEP S103
CALCULATE INVERSE OF SEPARATION MATRIX AND EXTRACT AND STORE COLUMNS OF INVERSE MATRIX AS BASIS VECTORS
S111
NORMALIZE BASIS VECTORS INTO FREQUENCY-INDEPENDENT FREQUENCY-NORMALIZED VECTORS AND STORE THEM
S112
S113
NORMALIZE FREQUENCY-NORMALIZED VECTORS INTO NORMALIZED BASIS VECTORS WHOSE NORM IS PREDETERMINED VALUE AND STORE THEM
CLUSTER NORMALIZED BASIS VECTORS INTO CLUSTERS AND CALCULATE AND STORE CENTROID OF EACH CLUSTER
S114
SELECT CLUSTER IN EACH FREQUENCY ON THE BASIS OF VARIANCE AND STORE IT
S115
SELECT AND STORE SELECTION SIGNAL IN EACH FREQUENCY AND CORRESPONDING BASIS VECTOR ON THE BASIS OF CLUSTER SELECTION INFORMATION
S116
END OF STEP S103

FIG.21A

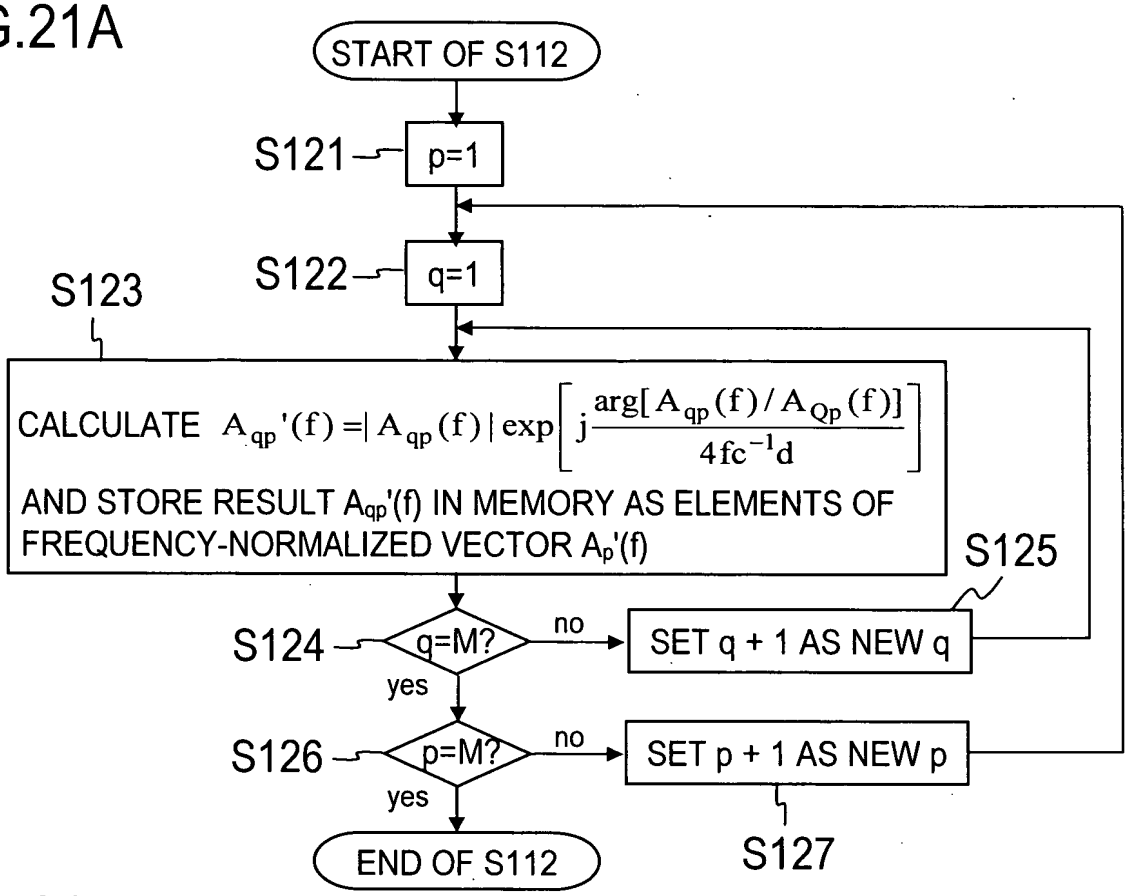


FIG.21B

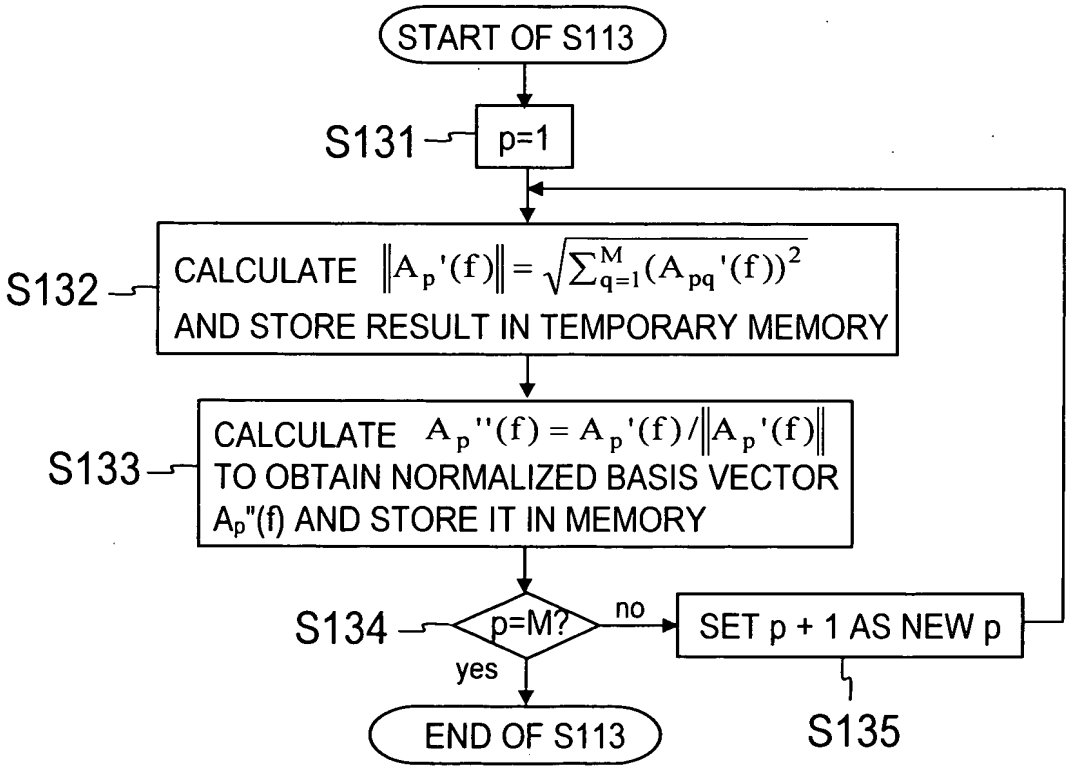


FIG.22

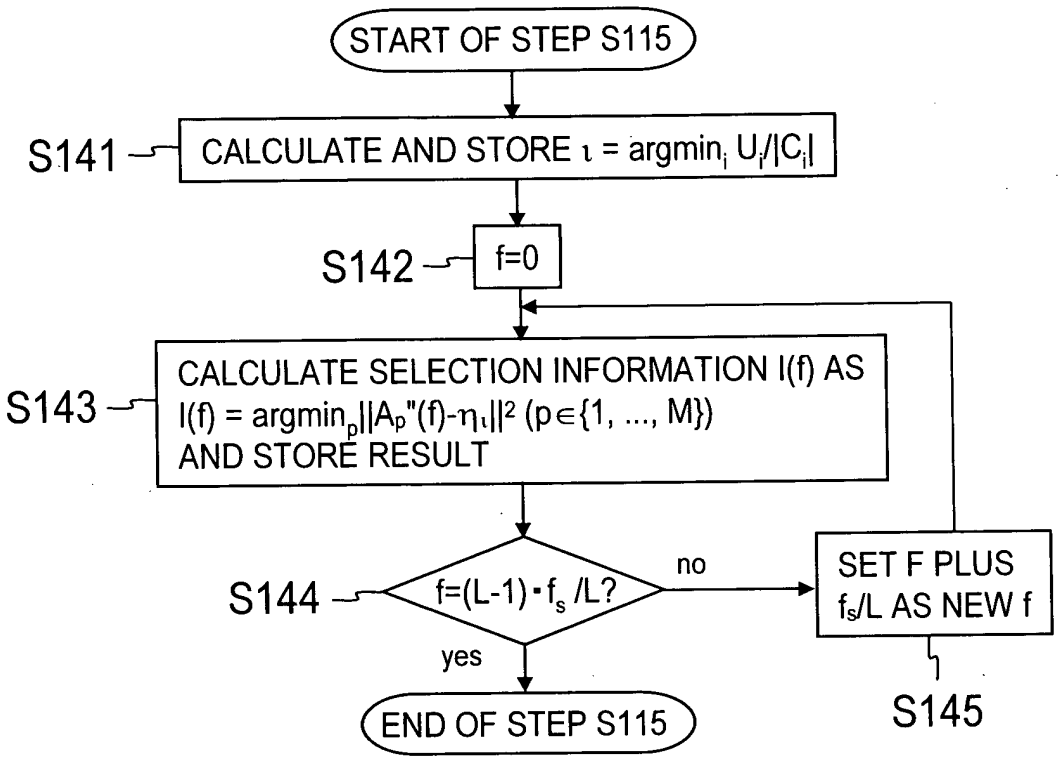

START OF STEP S115
S141
CALCULATE AND STORE ι = argmin$_i$ $U_i/|C_i|$
S142
f=0
S143
CALCULATE SELECTION INFORMATION I(f) AS
I(f) = argmin$_p$||A_p"(f)-η_ι||^2 (p∈{1, ..., M})
AND STORE RESULT
S144
f=(L-1)・f_s /L?
no
SET F PLUS
f_s/L AS NEW f
S145
yes
END OF STEP S115

FIG.23

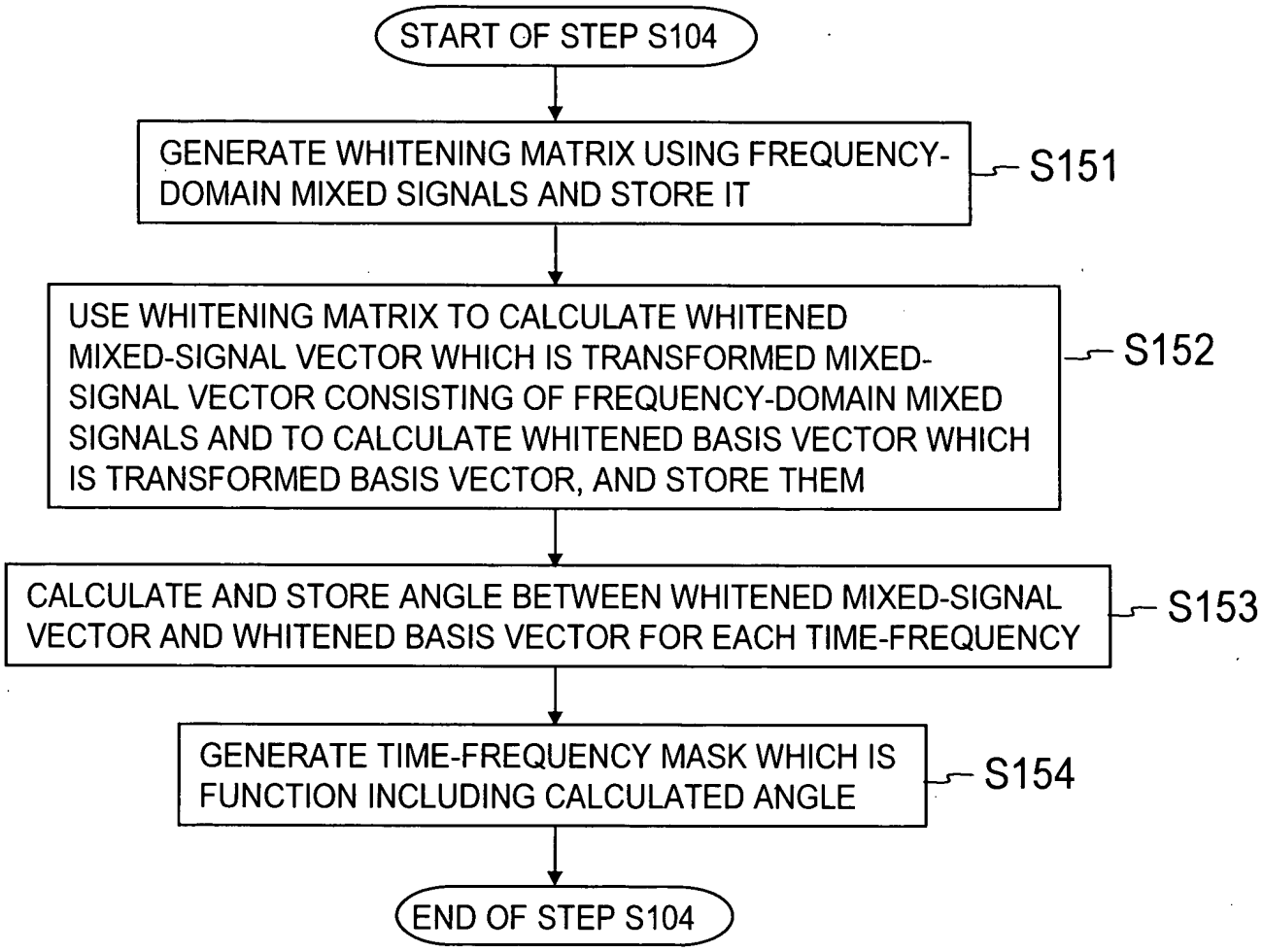

START OF STEP S104
GENERATE WHITENING MATRIX USING FREQUENCY-DOMAIN MIXED SIGNALS AND STORE IT
S151
USE WHITENING MATRIX TO CALCULATE WHITENED MIXED-SIGNAL VECTOR WHICH IS TRANSFORMED MIXED-SIGNAL VECTOR CONSISTING OF FREQUENCY-DOMAIN MIXED SIGNALS AND TO CALCULATE WHITENED BASIS VECTOR WHICH IS TRANSFORMED BASIS VECTOR, AND STORE THEM
S152
CALCULATE AND STORE ANGLE BETWEEN WHITENED MIXED-SIGNAL VECTOR AND WHITENED BASIS VECTOR FOR EACH TIME-FREQUENCY
S153
GENERATE TIME-FREQUENCY MASK WHICH IS FUNCTION INCLUDING CALCULATED ANGLE
S154
END OF STEP S104

FIG.24A

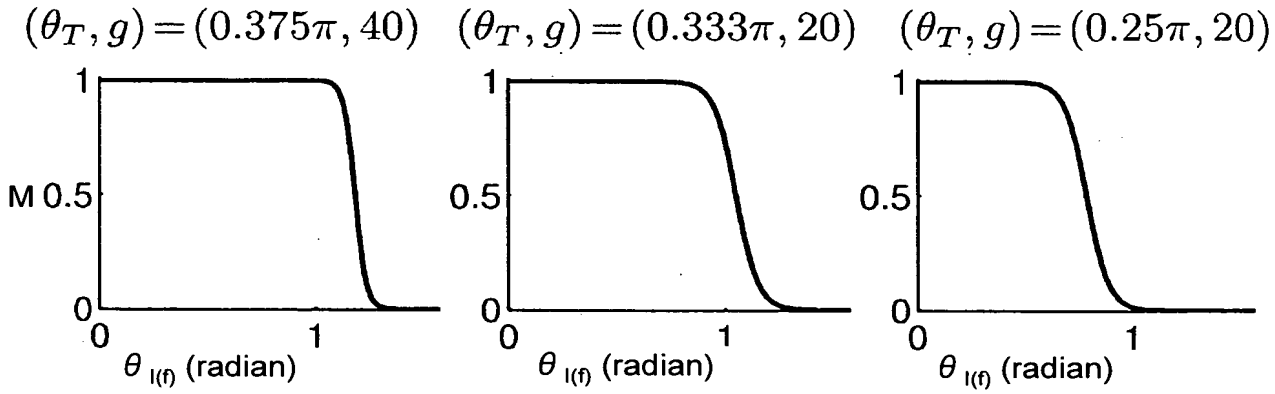


FIG.24B

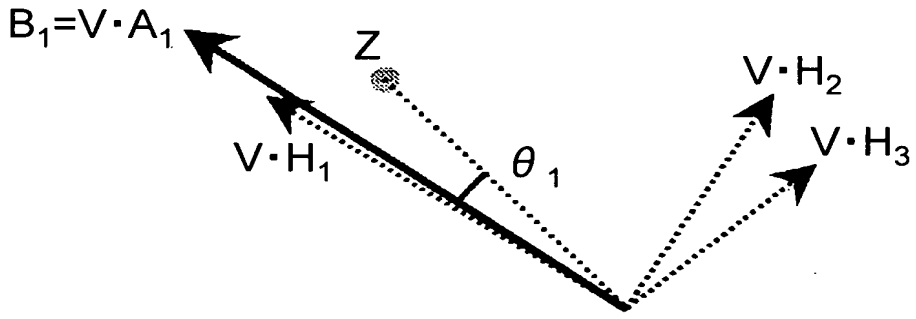


FIG.25

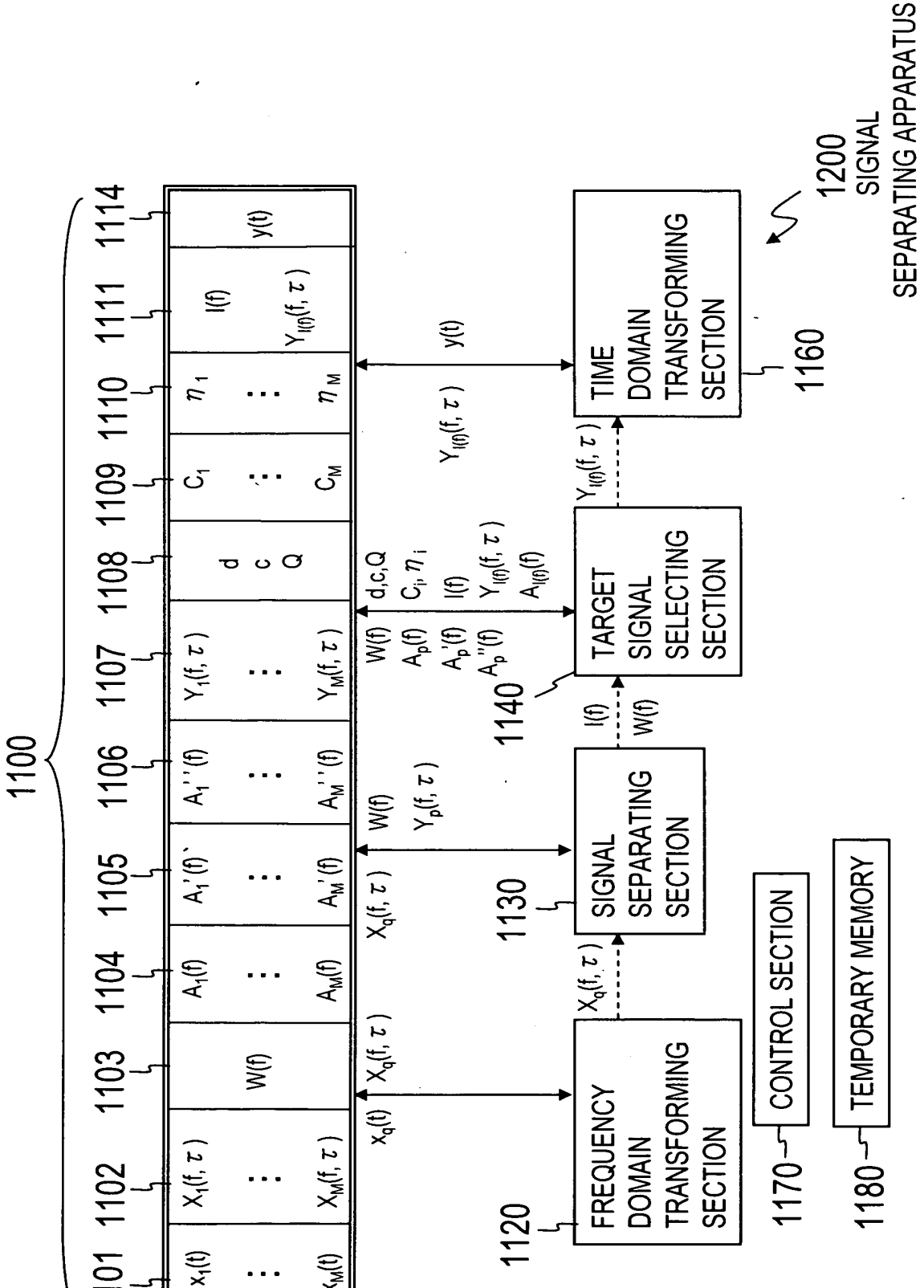

1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1114
$x_1(t)$
$x_M(t)$
$X_1(f, \tau)$
$X_M(f, \tau)$
W(f)
$A_1(f)$
$A_M(f)$
$A_1'(f)$
$A_M'(f)$
$A_1''(f)$
$A_M''(f)$
$Y_1(f, \tau)$
$Y_M(f, \tau)$
d
c
Q
C_1
C_M
η_1
η_M
I(f)
$Y_{I(f)}(f, \tau)$
y(t)
1120
FREQUENCY DOMAIN TRANSFORMING SECTION
$x_q(t)$
$X_q(f, \tau)$
1130
SIGNAL SEPARATING SECTION
$X_q(f, \tau)$
W(f)
$Y_p(f, \tau)$
1140
TARGET SIGNAL SELECTING SECTION
I(f)
W(f)
d,c,Q
C_i, η_i
I(f)
$Y_{I(f)}(f, \tau)$
$A_{I(f)}(f)$
$A_p(f)$
$A_p'(f)$
$A_p''(f)$
$Y_{I(f)}(f, \tau)$
$Y_{I(f)}(f, \tau)$
y(t)
1160
TIME DOMAIN TRANSFORMING SECTION
1200
SIGNAL SEPARATING APPARATUS
1170
CONTROL SECTION
1180
TEMPORARY MEMORY

FIG.26

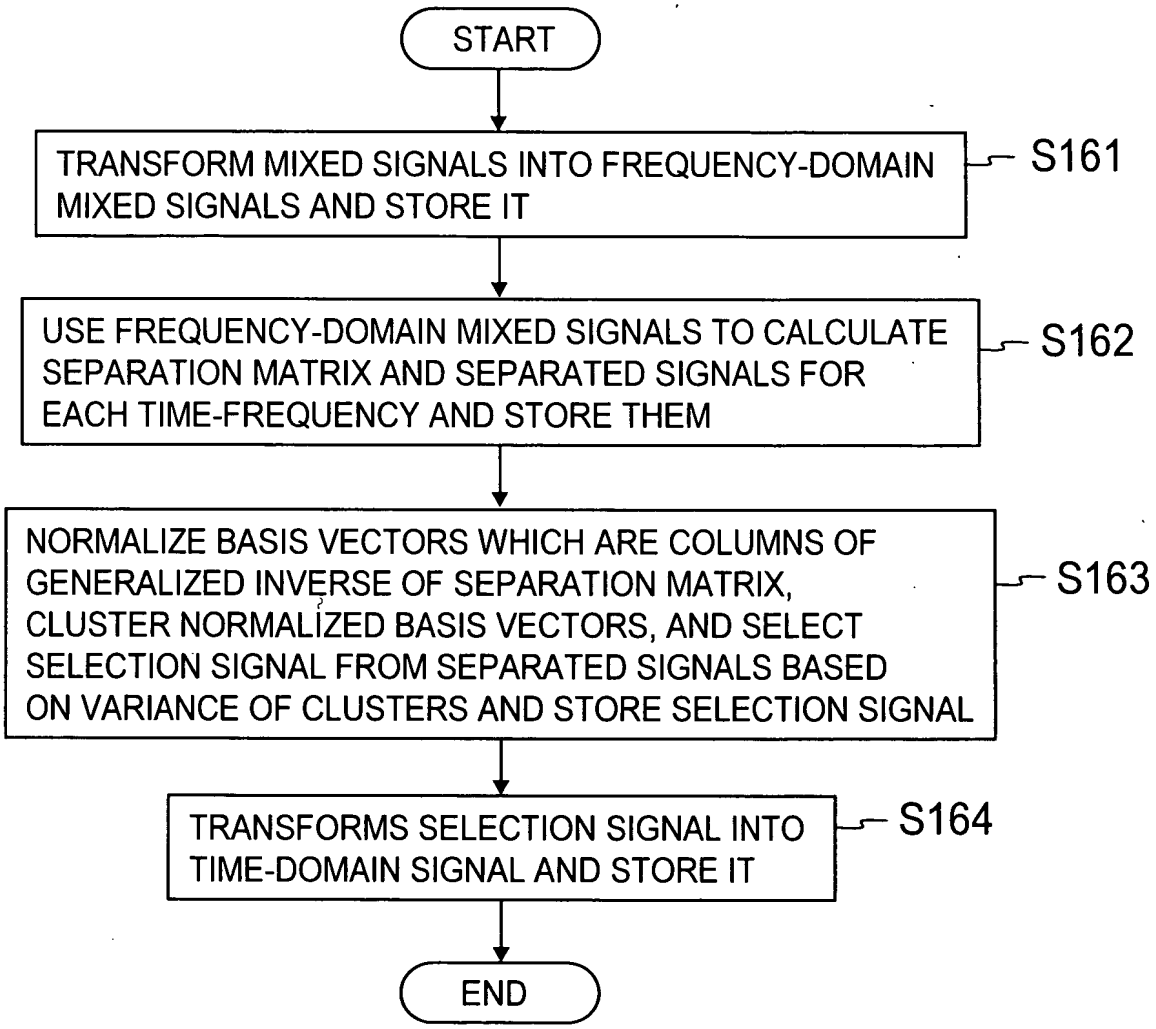

START
TRANSFORM MIXED SIGNALS INTO FREQUENCY-DOMAIN MIXED SIGNALS AND STORE IT
S161
USE FREQUENCY-DOMAIN MIXED SIGNALS TO CALCULATE SEPARATION MATRIX AND SEPARATED SIGNALS FOR EACH TIME-FREQUENCY AND STORE THEM
S162
NORMALIZE BASIS VECTORS WHICH ARE COLUMNS OF GENERALIZED INVERSE OF SEPARATION MATRIX, CLUSTER NORMALIZED BASIS VECTORS, AND SELECT SELECTION SIGNAL FROM SEPARATED SIGNALS BASED ON VARIANCE OF CLUSTERS AND STORE SELECTION SIGNAL
S163
TRANSFORMS SELECTION SIGNAL INTO TIME-DOMAIN SIGNAL AND STORE IT
S164
END

FIG.27

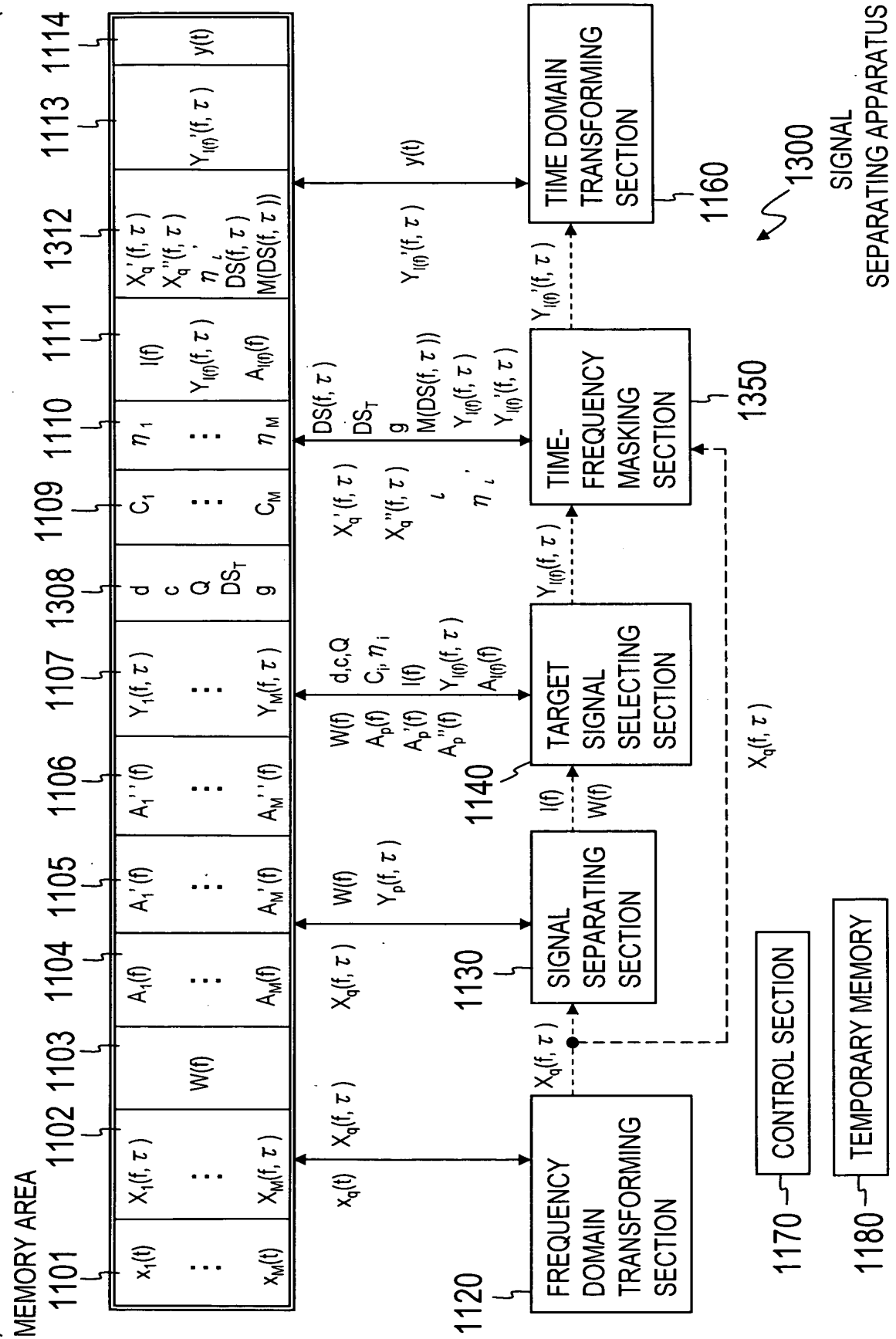

1100 MEMORY
MEMORY AREA
1101
1102
1103
1104
1105
1106
1107
1308
1109
1110
1111
1312
1113
1114
$x_1(t)$
$x_M(t)$
$X_1(f, \tau)$
$X_M(f, \tau)$
W(f)
$A_1(f)$
$A_M(f)$
$A_1'(f)$
$A_M'(f)$
$A_1''(f)$
$A_M''(f)$
$Y_1(f, \tau)$
$Y_M(f, \tau)$
d
c
Q
DS_T
g
C_1
C_M
η_1
η_M
I(f)
$Y_{I(f)}(f, \tau)$
$A_{I(f)}(f)$
$X_q'(f, \tau)$
$X_q''(f, \tau)$
η_i'
$DS(f, \tau)$
$M(DS(f, \tau))$
$Y_{I(f)}'(f, \tau)$
y(t)
$x_q(t)$
$X_q(f, \tau)$
$Y_p(f, \tau)$
W(f)
$A_p(f)$
$A_p'(f)$
$A_p''(f)$
d,c,Q
C_i, η_i
I(f)
1120
FREQUENCY DOMAIN TRANSFORMING SECTION
1130
SIGNAL SEPARATING SECTION
1140
TARGET SIGNAL SELECTING SECTION
1350
TIME-FREQUENCY MASKING SECTION
1160
TIME DOMAIN TRANSFORMING SECTION
1300
SIGNAL SEPARATING APPARATUS
1170
CONTROL SECTION
1180
TEMPORARY MEMORY

FIG.28A

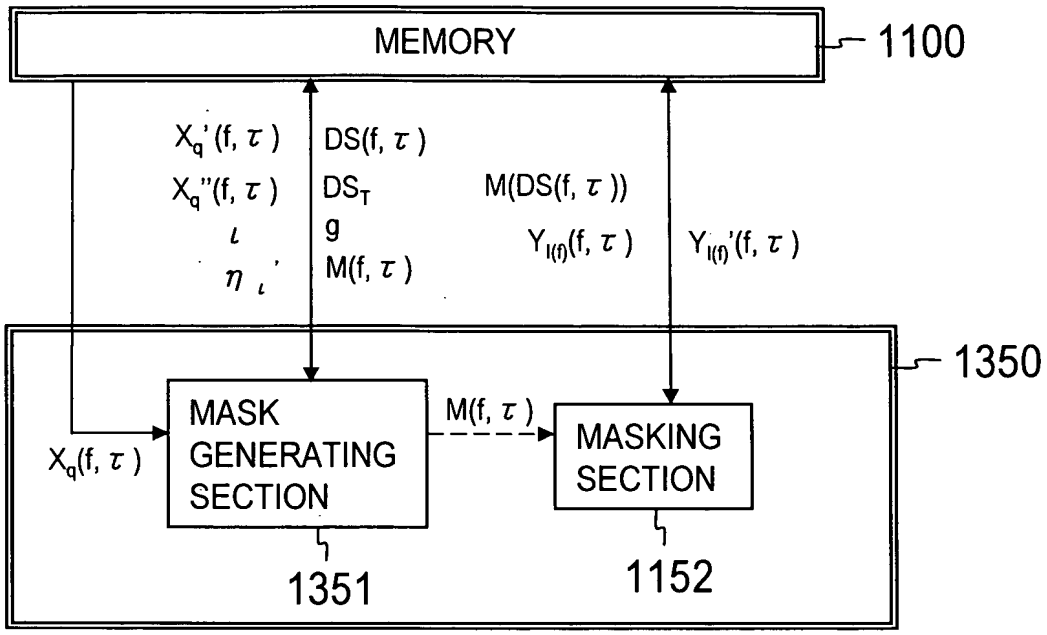


FIG.28B

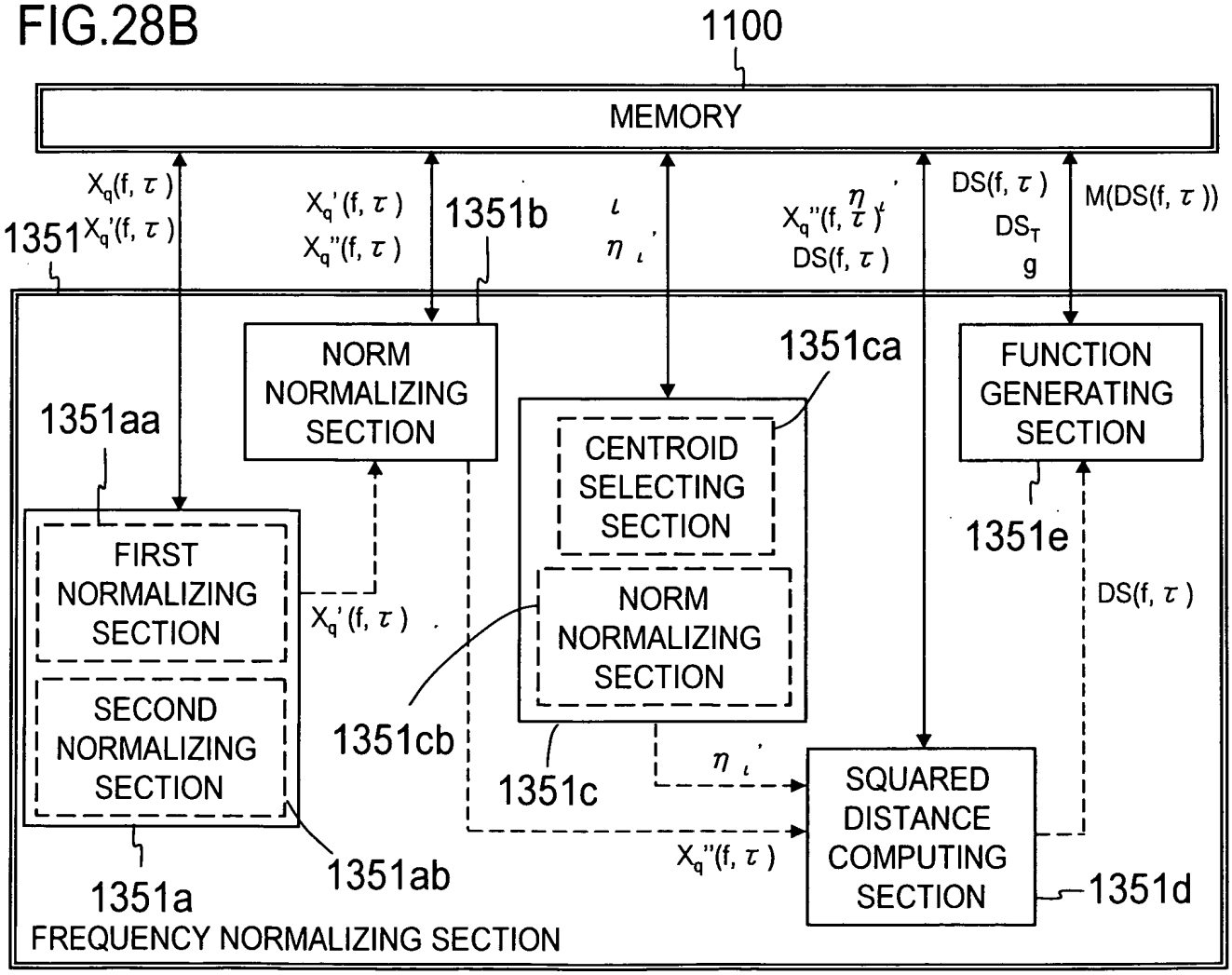


FIG.29

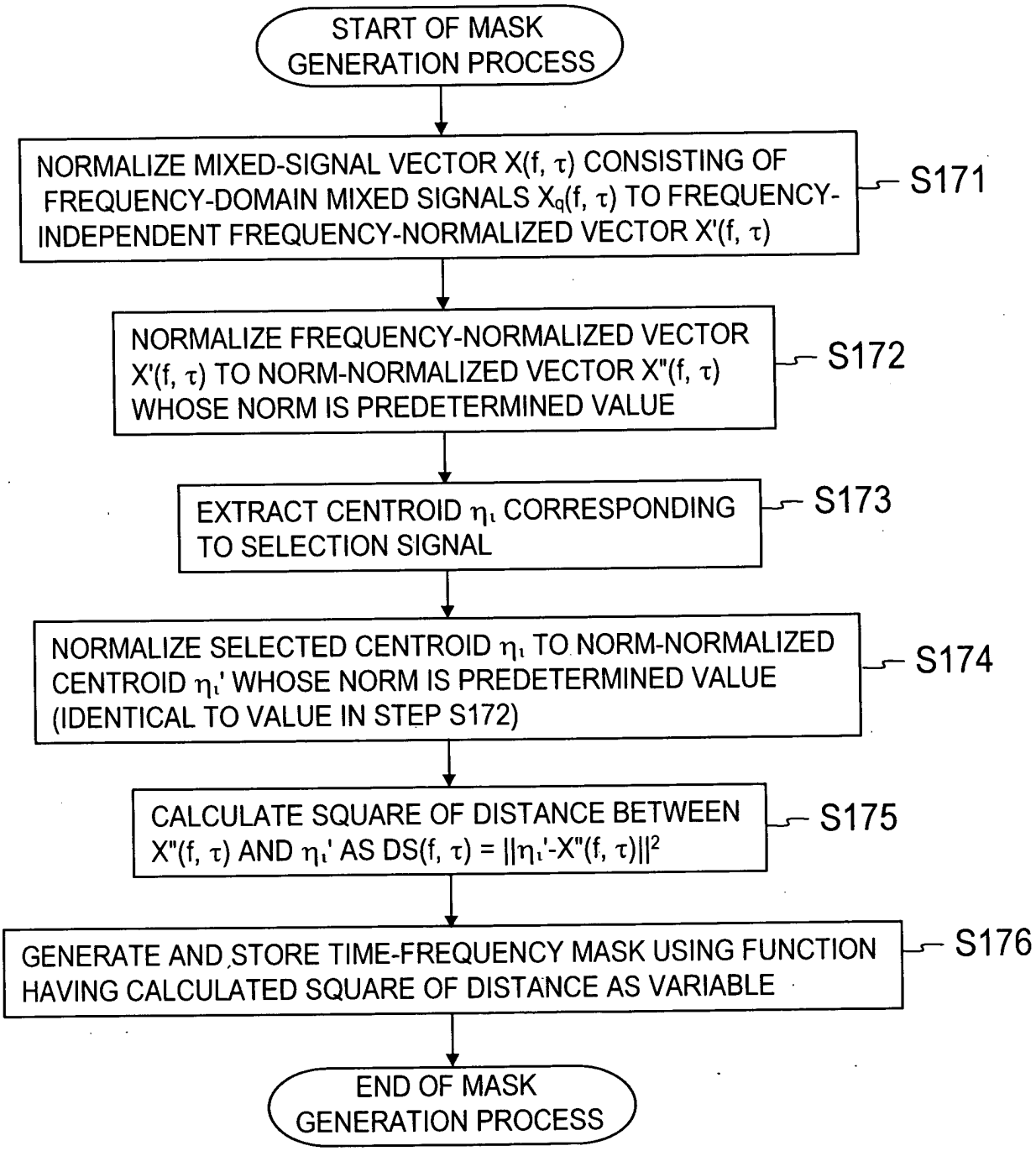

START OF MASK GENERATION PROCESS
NORMALIZE MIXED-SIGNAL VECTOR X(f, τ) CONSISTING OF FREQUENCY-DOMAIN MIXED SIGNALS $X_q(f, \tau)$ TO FREQUENCY-INDEPENDENT FREQUENCY-NORMALIZED VECTOR X'(f, τ)
S171
NORMALIZE FREQUENCY-NORMALIZED VECTOR X'(f, τ) TO NORM-NORMALIZED VECTOR X"(f, τ) WHOSE NORM IS PREDETERMINED VALUE
S172
EXTRACT CENTROID η_ι CORRESPONDING TO SELECTION SIGNAL
S173
NORMALIZE SELECTED CENTROID η_ι TO NORM-NORMALIZED CENTROID η_ι' WHOSE NORM IS PREDETERMINED VALUE (IDENTICAL TO VALUE IN STEP S172)
S174
CALCULATE SQUARE OF DISTANCE BETWEEN X"(f, τ) AND η_ι' AS $DS(f, \tau) = ||\eta_\iota' - X"(f, \tau)||^2$
S175
GENERATE AND STORE TIME-FREQUENCY MASK USING FUNCTION HAVING CALCULATED SQUARE OF DISTANCE AS VARIABLE
S176
END OF MASK GENERATION PROCESS

FIG.30A

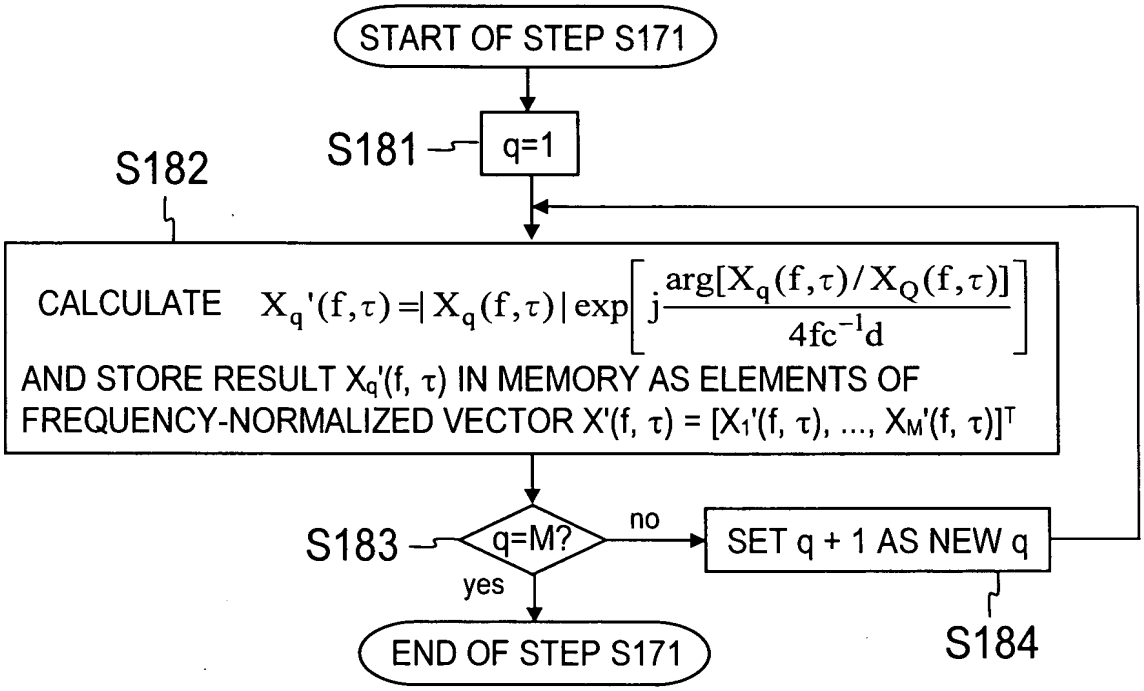


FIG.30B

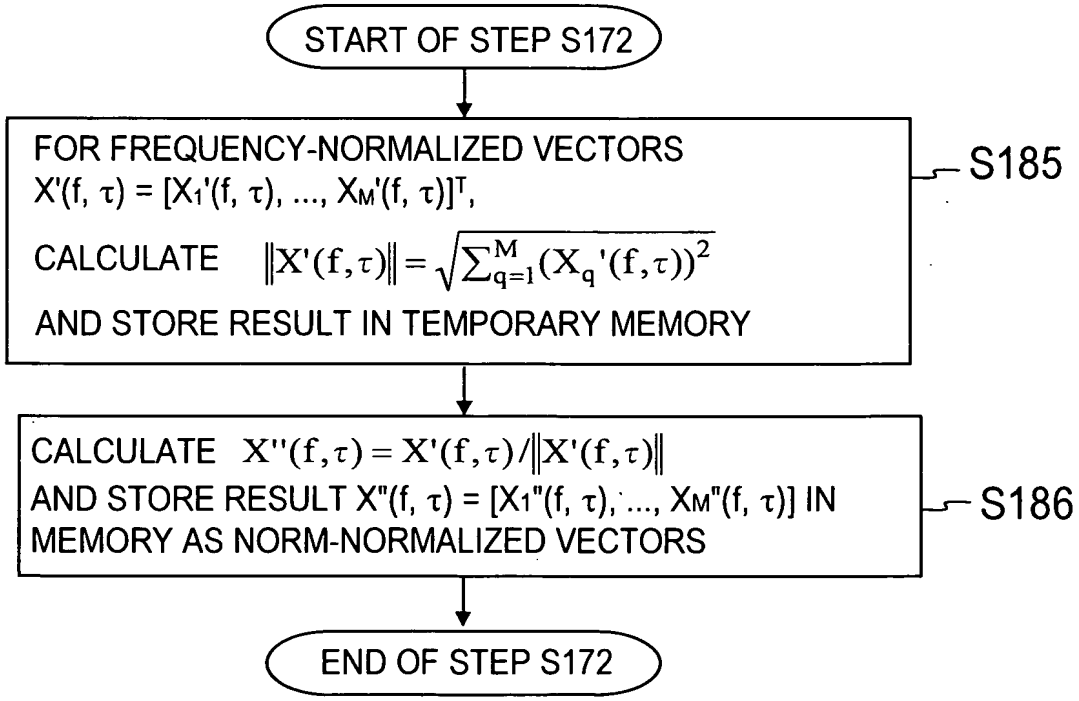


FIG.31A

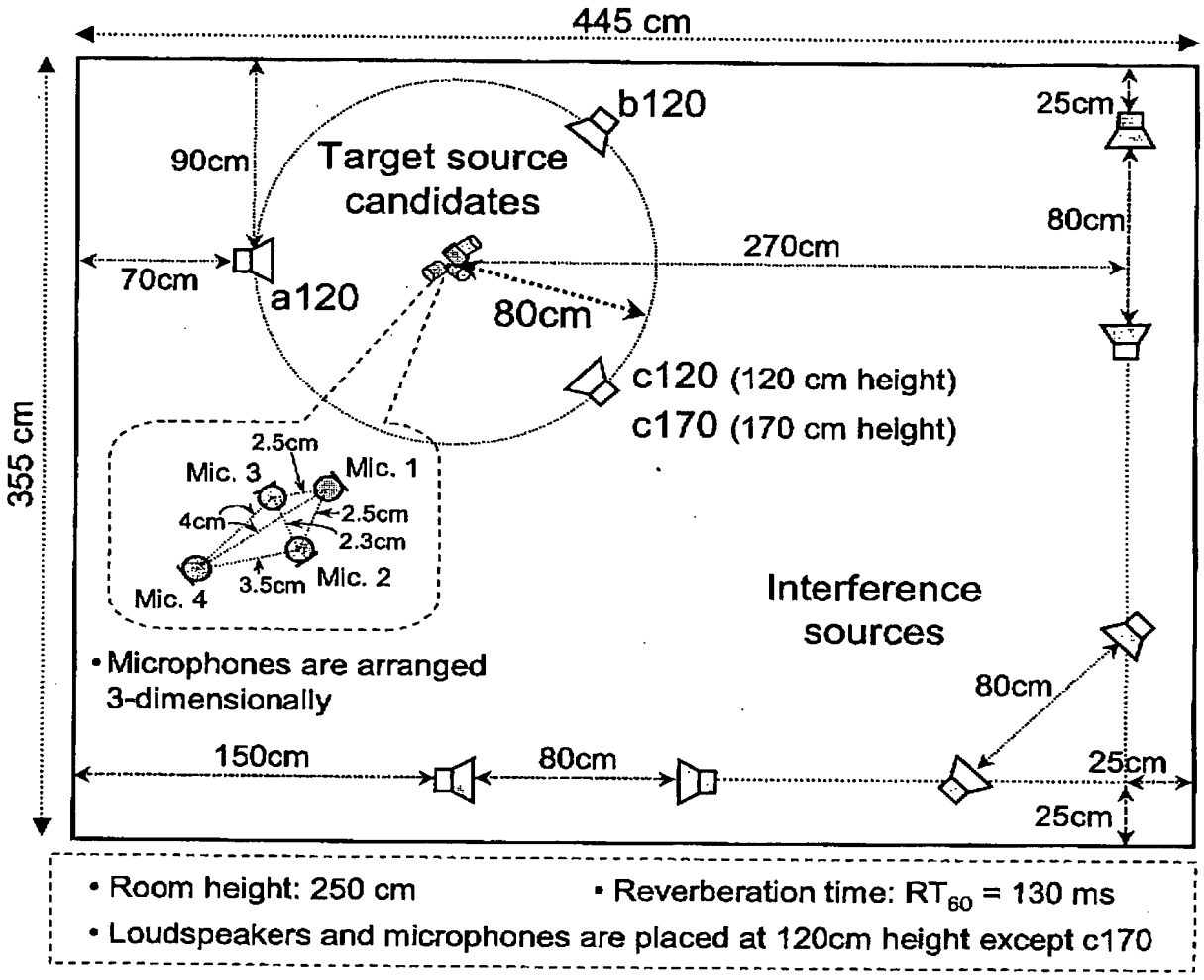


FIG.31B

TARGET SOUND POSITION	a120	b120	c120	c170
ICA ONLY	11.7dB	11.7dB	9.0dB	12.9dB
ICA WITH MASKING (0.375 π ,40)	15.5dB	14.3dB	12.4dB	16.7dB
ICA WITH MASKING (0.333 π ,20)	16.9dB	15.4dB	14.0dB	18.1dB
ICA WITH MASKING (0.25 π ,20)	19.7dB	17.9dB	16.9dB	20.8dB

FIG.32

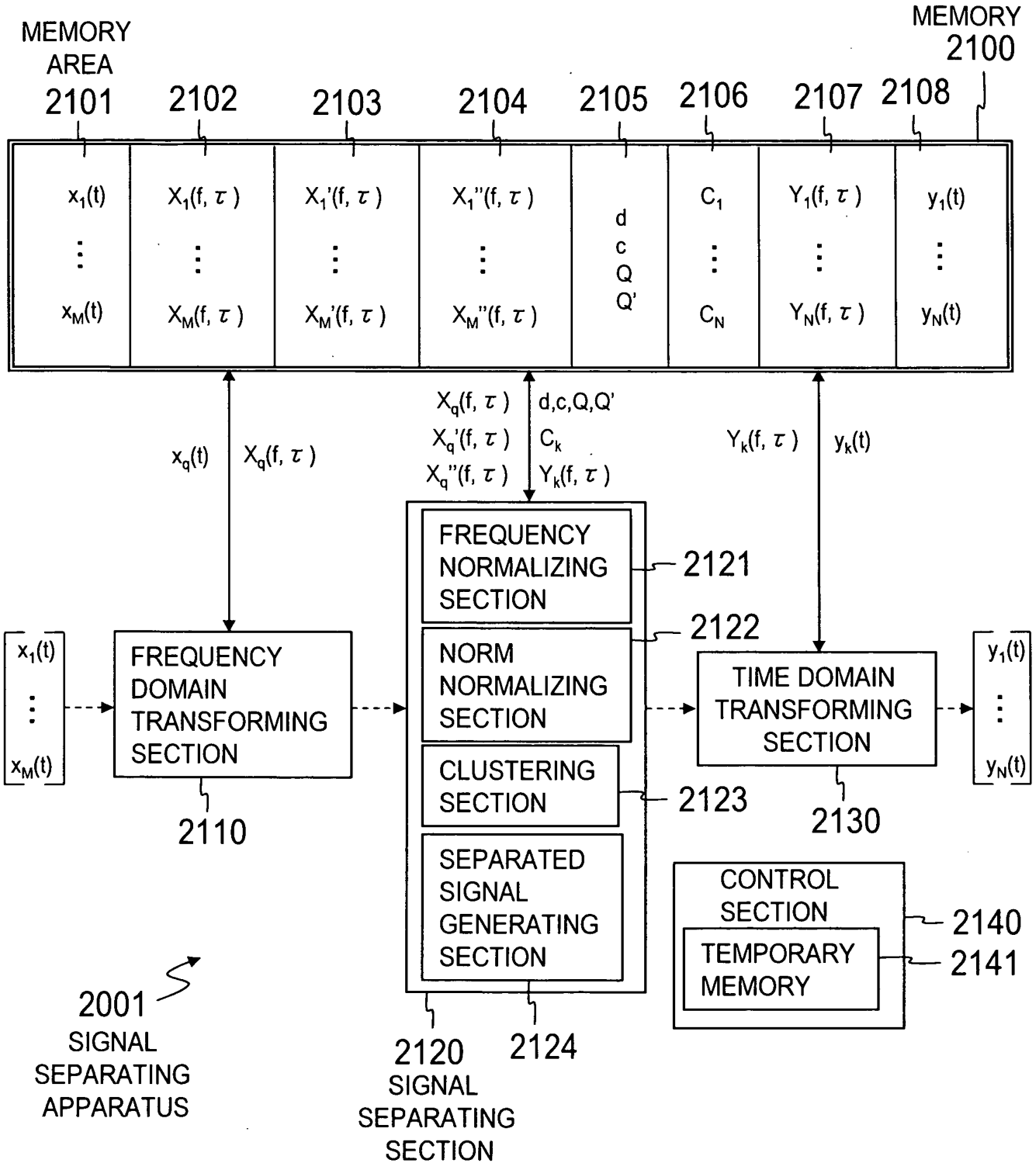

MEMORY AREA
2101
2102
2103
2104
2105
2106
2107
2108
MEMORY
2100
$x_1(t)$
$x_M(t)$
$X_1(f, \tau)$
$X_M(f, \tau)$
$X_1'(f, \tau)$
$X_M'(f, \tau)$
$X_1''(f, \tau)$
$X_M''(f, \tau)$
d
c
Q
Q'
C_1
C_N
$Y_1(f, \tau)$
$Y_N(f, \tau)$
$y_1(t)$
$y_N(t)$
$x_q(t)$
$X_q(f, \tau)$
$X_q(f, \tau)$
$X_q'(f, \tau)$
$X_q''(f, \tau)$
d,c,Q,Q'
C_k
$Y_k(f, \tau)$
$Y_k(f, \tau)$
$y_k(t)$
FREQUENCY NORMALIZING SECTION
2121
NORM NORMALIZING SECTION
2122
CLUSTERING SECTION
2123
SEPARATED SIGNAL GENERATING SECTION
FREQUENCY DOMAIN TRANSFORMING SECTION
2110
TIME DOMAIN TRANSFORMING SECTION
2130
CONTROL SECTION
2140
TEMPORARY MEMORY
2141
2001
SIGNAL SEPARATING APPARATUS
2120
2124
SIGNAL SEPARATING SECTION

FIG.33

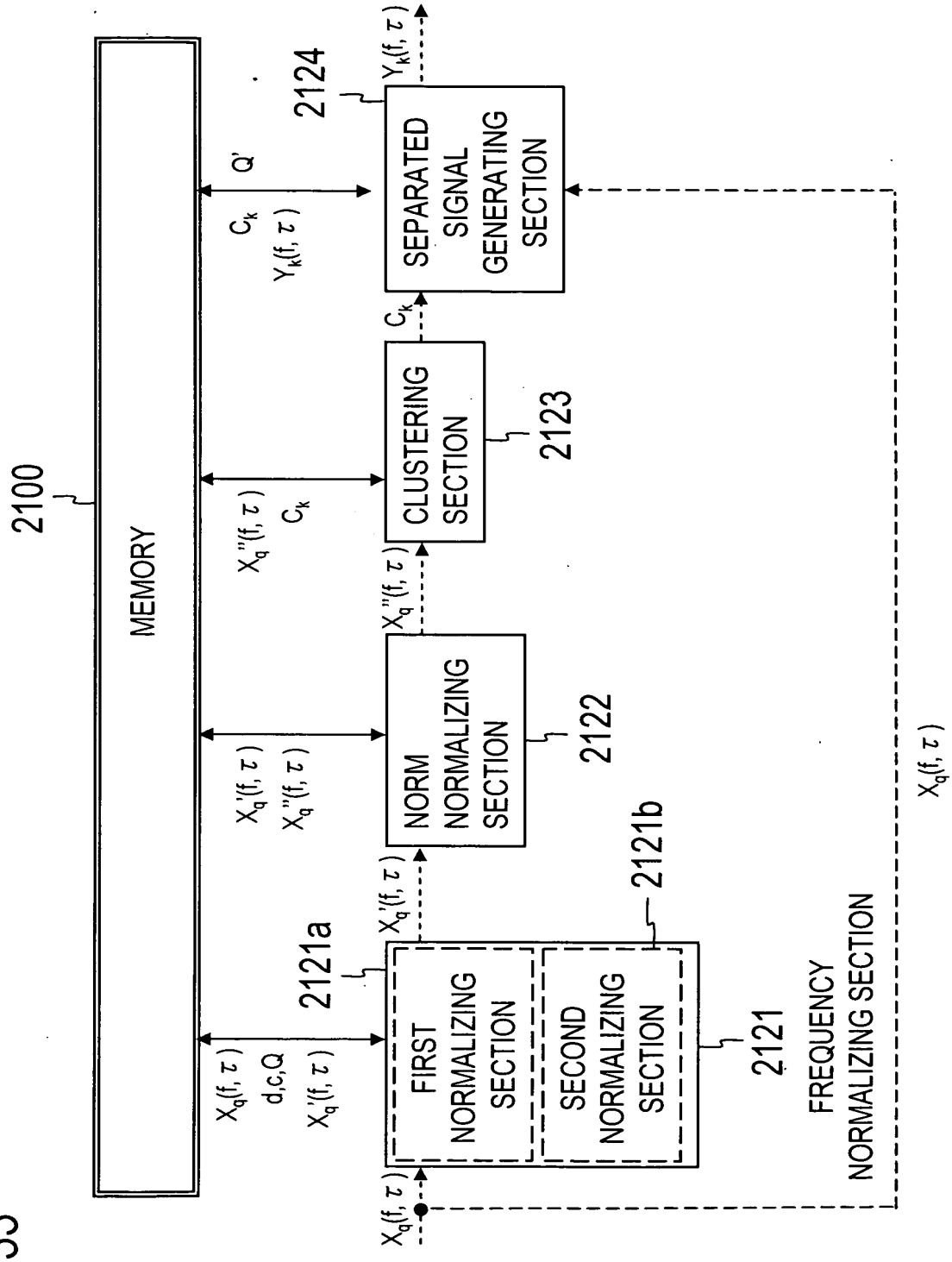

2100
MEMORY
2120
FREQUENCY NORMALIZING SECTION
2121
FIRST NORMALIZING SECTION
SECOND NORMALIZING SECTION
2121a
2121b
NORM NORMALIZING SECTION
2122
CLUSTERING SECTION
2123
SEPARATED SIGNAL GENERATING SECTION
2124
Q'
C_k
$Y_k(f, \tau)$
$X_q(f, \tau)$
$X_q'(f, \tau)$
$X_q''(f, \tau)$
d,c,Q

FIG.34

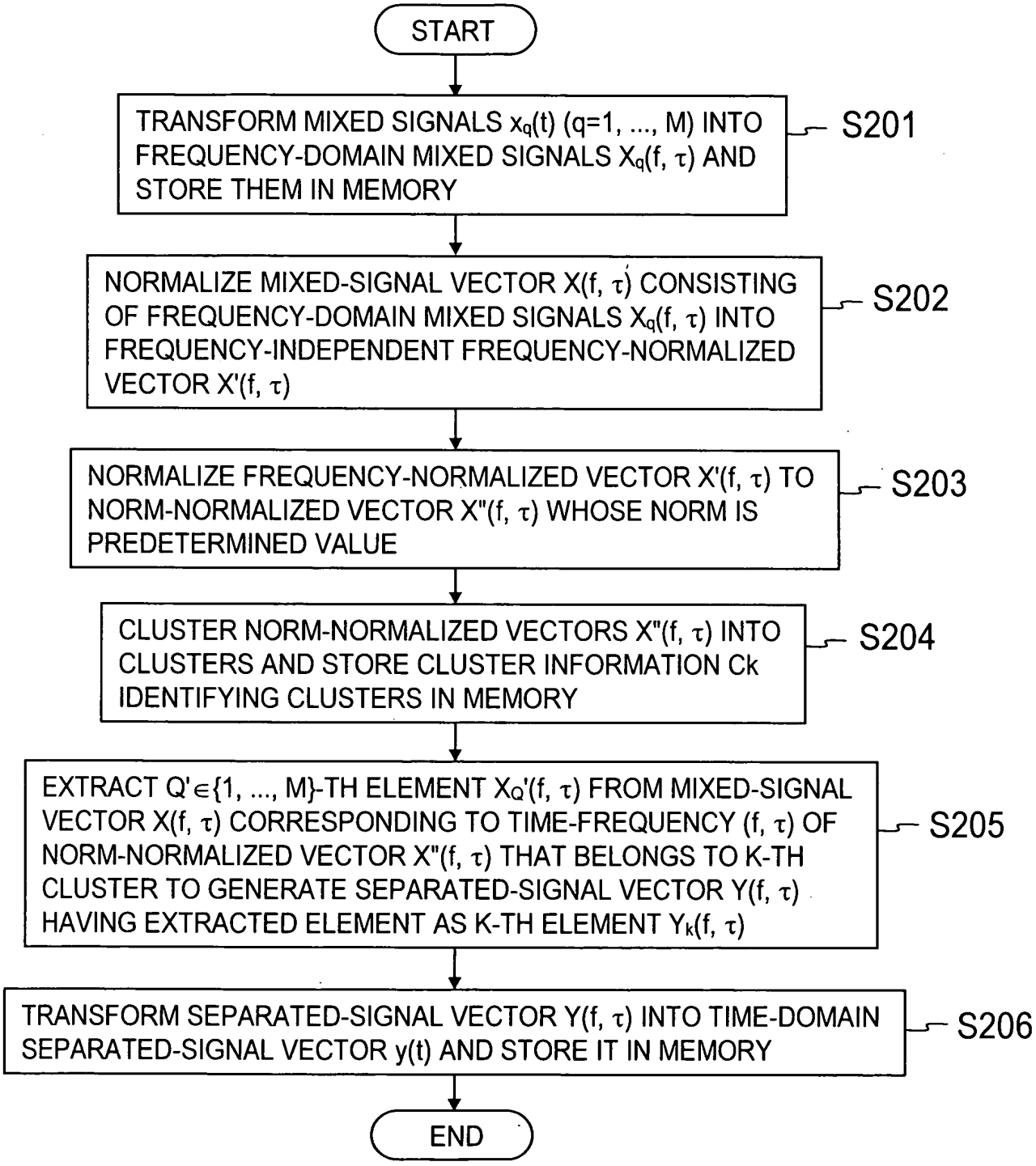

START
TRANSFORM MIXED SIGNALS $x_q(t)$ (q=1, ..., M) INTO FREQUENCY-DOMAIN MIXED SIGNALS $X_q(f, \tau)$ AND STORE THEM IN MEMORY
S201
NORMALIZE MIXED-SIGNAL VECTOR $X(f, \tau)$ CONSISTING OF FREQUENCY-DOMAIN MIXED SIGNALS $X_q(f, \tau)$ INTO FREQUENCY-INDEPENDENT FREQUENCY-NORMALIZED VECTOR $X'(f, \tau)$
S202
NORMALIZE FREQUENCY-NORMALIZED VECTOR $X'(f, \tau)$ TO NORM-NORMALIZED VECTOR $X''(f, \tau)$ WHOSE NORM IS PREDETERMINED VALUE
S203
CLUSTER NORM-NORMALIZED VECTORS $X''(f, \tau)$ INTO CLUSTERS AND STORE CLUSTER INFORMATION Ck IDENTIFYING CLUSTERS IN MEMORY
S204
EXTRACT $Q' \in \{1, ..., M\}$-TH ELEMENT $X_{Q'}(f, \tau)$ FROM MIXED-SIGNAL VECTOR $X(f, \tau)$ CORRESPONDING TO TIME-FREQUENCY (f, τ) OF NORM-NORMALIZED VECTOR $X''(f, \tau)$ THAT BELONGS TO K-TH CLUSTER TO GENERATE SEPARATED-SIGNAL VECTOR $Y(f, \tau)$ HAVING EXTRACTED ELEMENT AS K-TH ELEMENT $Y_k(f, \tau)$
S205
TRANSFORM SEPARATED-SIGNAL VECTOR $Y(f, \tau)$ INTO TIME-DOMAIN SEPARATED-SIGNAL VECTOR y(t) AND STORE IT IN MEMORY
S206
END

FIG.35A

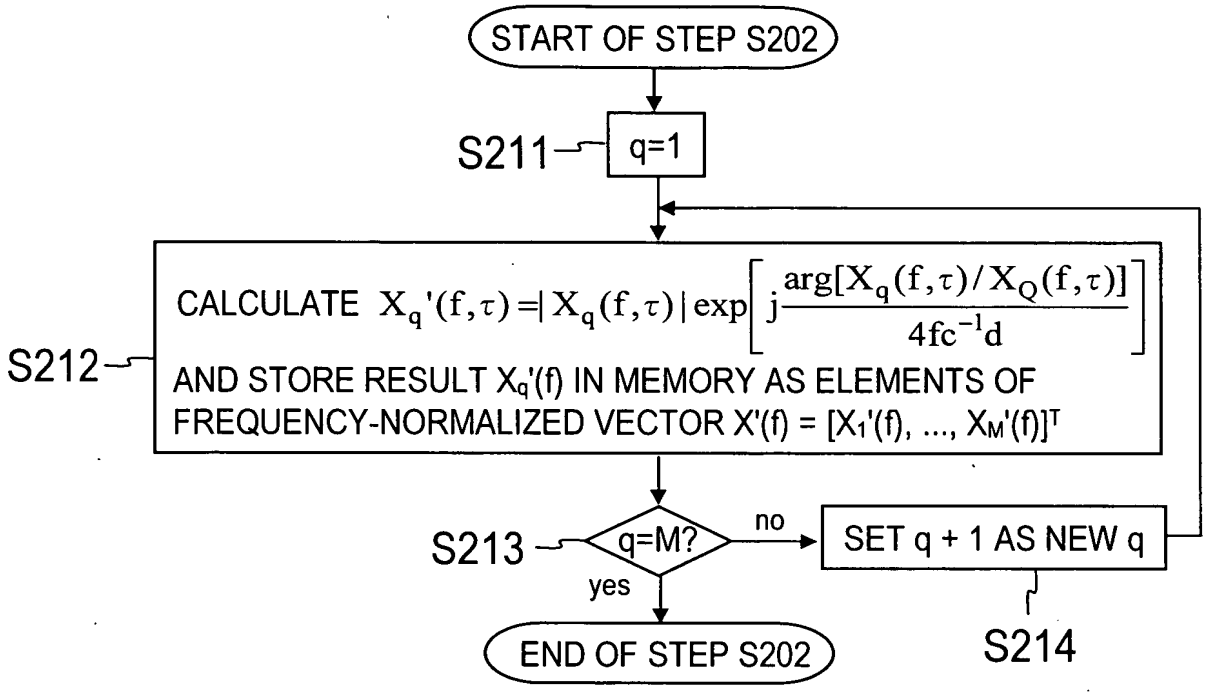


FIG.35B

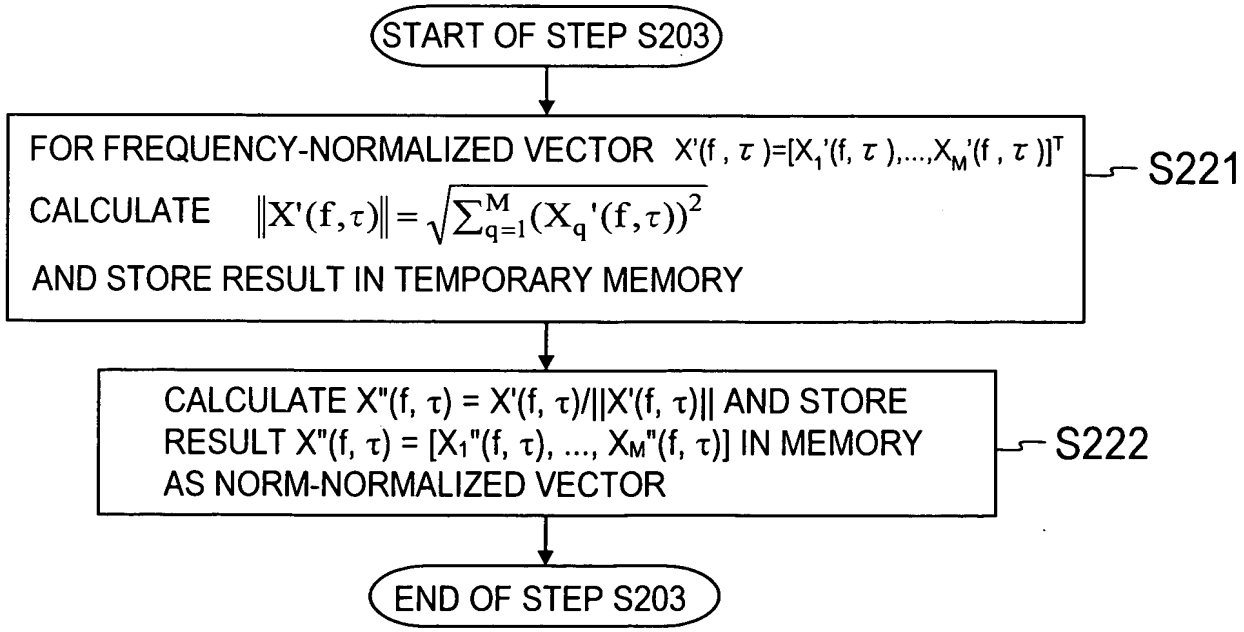


FIG.36

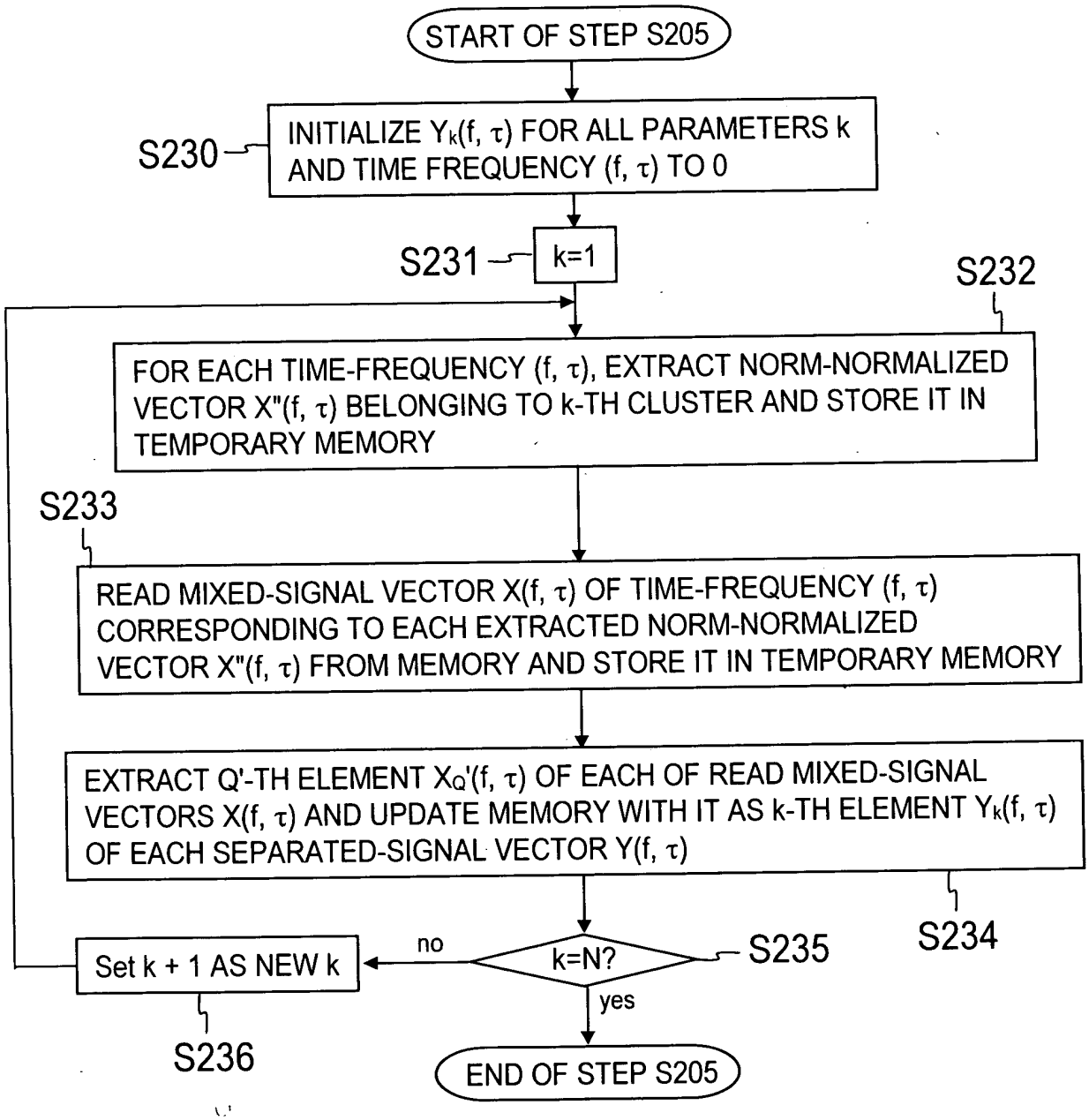

START OF STEP S205
S230
INITIALIZE $Y_k(f, \tau)$ FOR ALL PARAMETERS k AND TIME FREQUENCY (f, τ) TO 0
S231
k=1
S232
FOR EACH TIME-FREQUENCY (f, τ), EXTRACT NORM-NORMALIZED VECTOR $X''(f, \tau)$ BELONGING TO k-TH CLUSTER AND STORE IT IN TEMPORARY MEMORY
S233
READ MIXED-SIGNAL VECTOR $X(f, \tau)$ OF TIME-FREQUENCY (f, τ) CORRESPONDING TO EACH EXTRACTED NORM-NORMALIZED VECTOR $X''(f, \tau)$ FROM MEMORY AND STORE IT IN TEMPORARY MEMORY
EXTRACT Q'-TH ELEMENT $X_{Q'}(f, \tau)$ OF EACH OF READ MIXED-SIGNAL VECTORS $X(f, \tau)$ AND UPDATE MEMORY WITH IT AS k-TH ELEMENT $Y_k(f, \tau)$ OF EACH SEPARATED-SIGNAL VECTOR $Y(f, \tau)$
S234
k=N?
S235
no
yes
Set k + 1 AS NEW k
S236
END OF STEP S205

FIG.37A

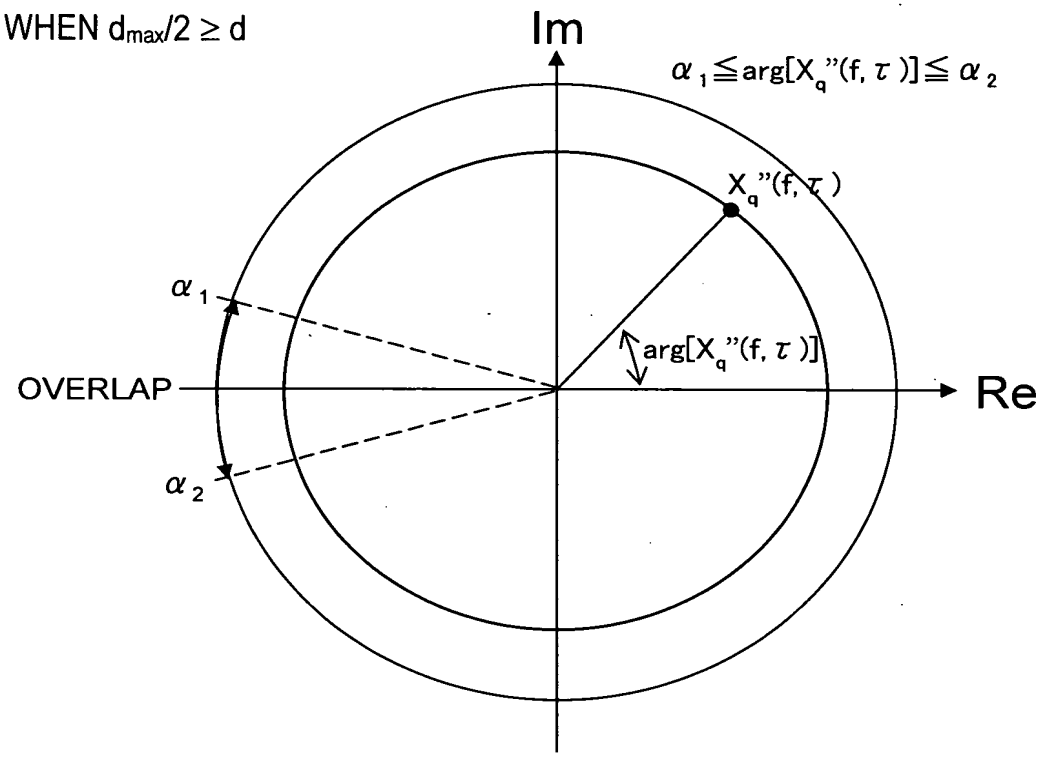


FIG.37B

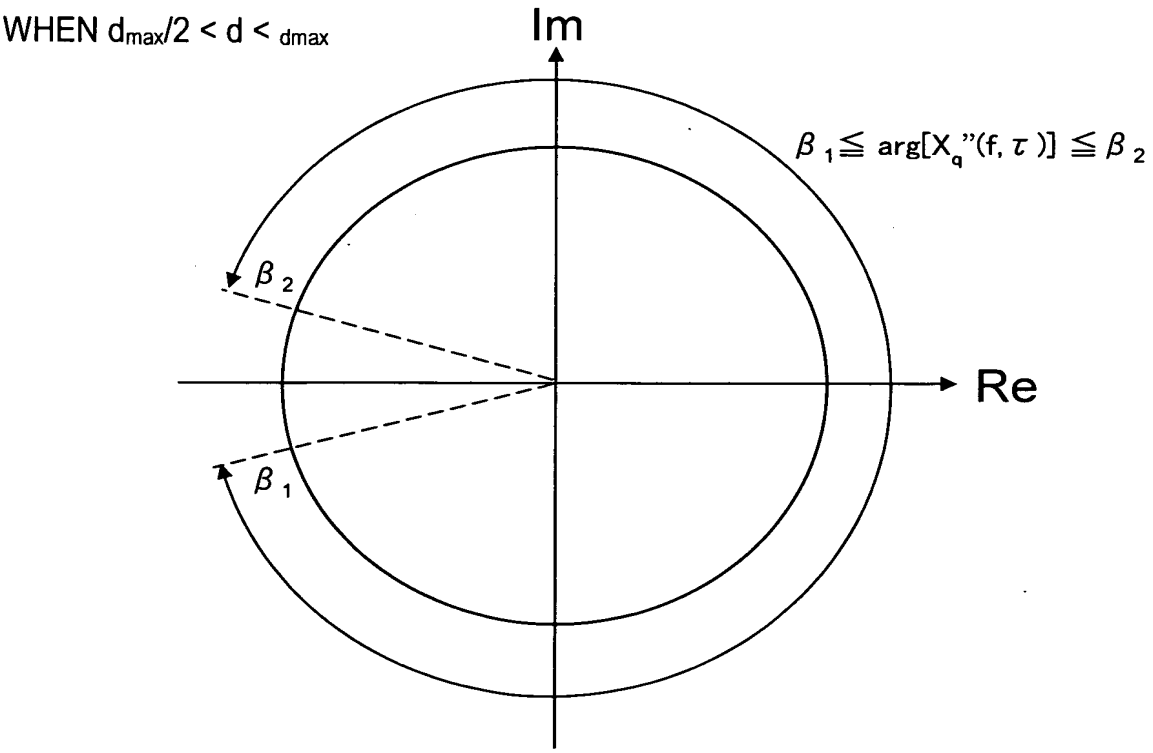


FIG.38A

WHEN $d = d_{max}$

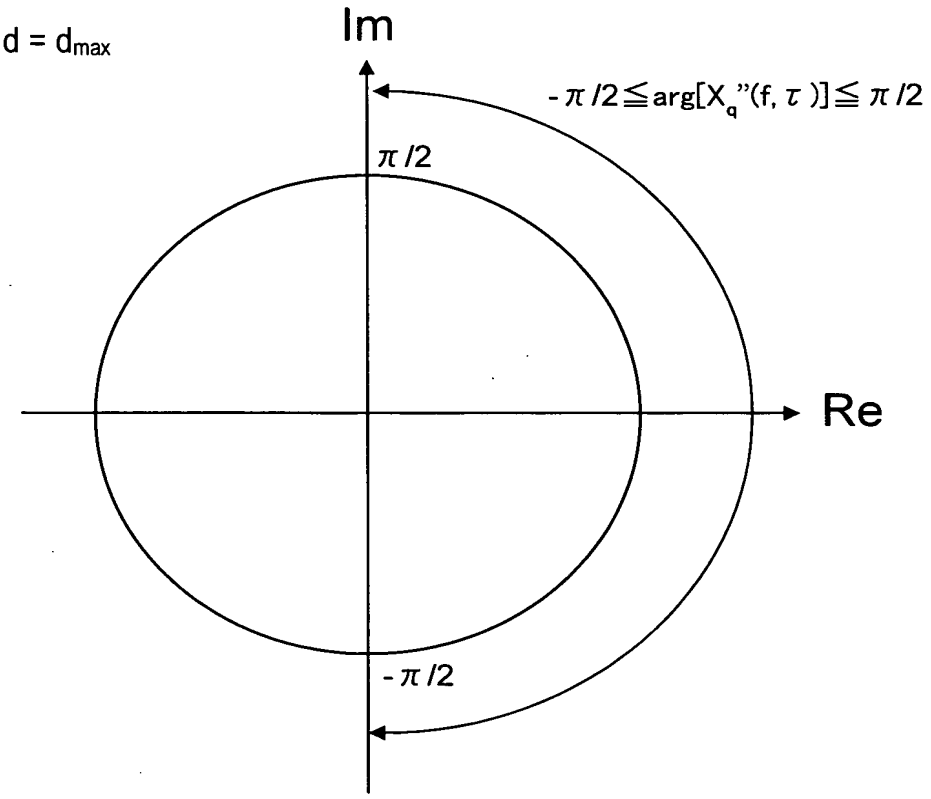


FIG.38B

WHEN $d > d_{max}$

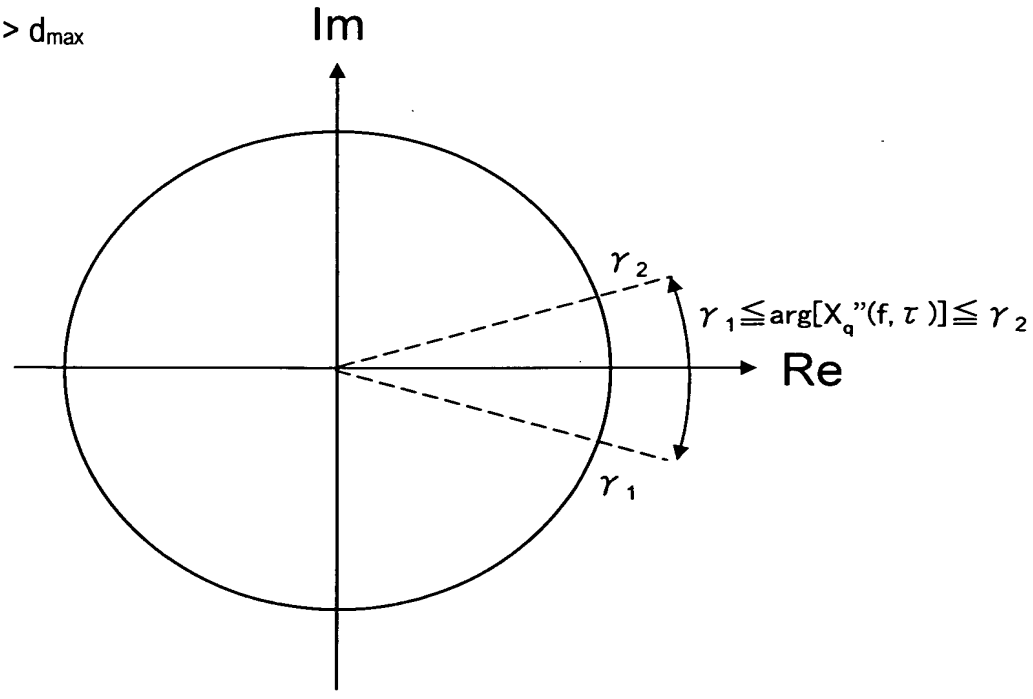


FIG.39A

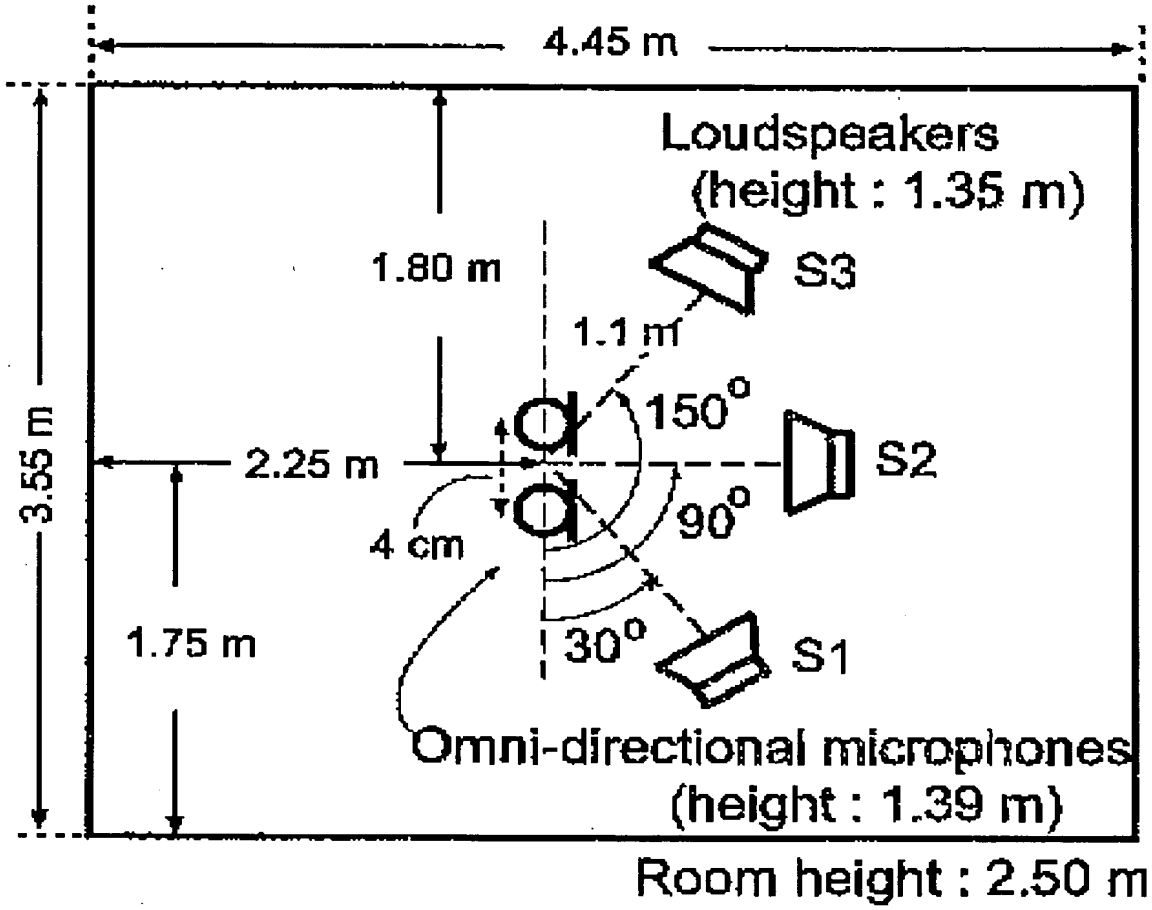


FIG.39B

EXPERIMENTAL RESULTS (in[dB])

	SIR_1	SIR_2	SIR_3
InputSIR	-5.2	-1.5	-2.9
DOA (Previous)	17.7	6.3	12.7
Normalized obser. vector (Proposed)	16.4	6.0	13.0

FIG.40A

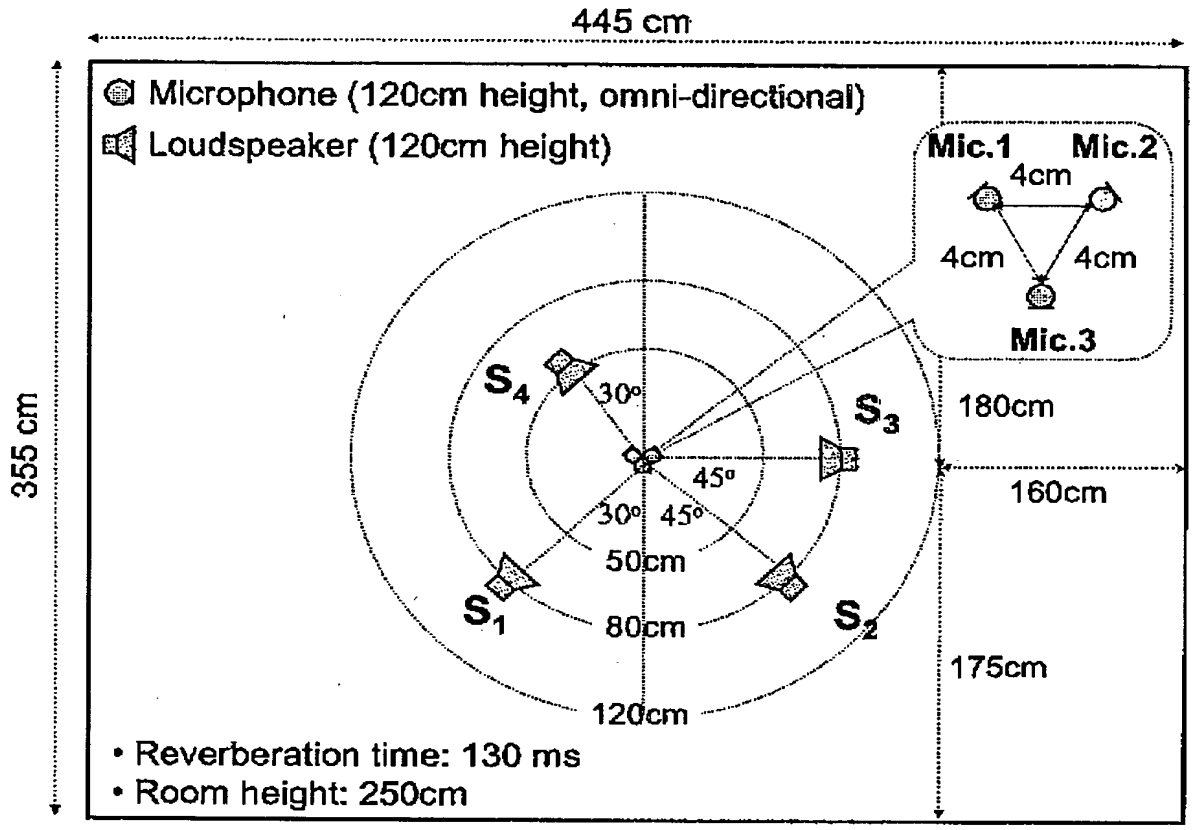


FIG.40B

EXPERIMENTAL RESULTS (in[dB])

	SIR_1	SIR_2	SIR_3	SIR_4
InputSIR	-8.1	-6.0	-5.9	-0.8
Proposed	16.8	10.6	14.5	10.8

FIG.41A

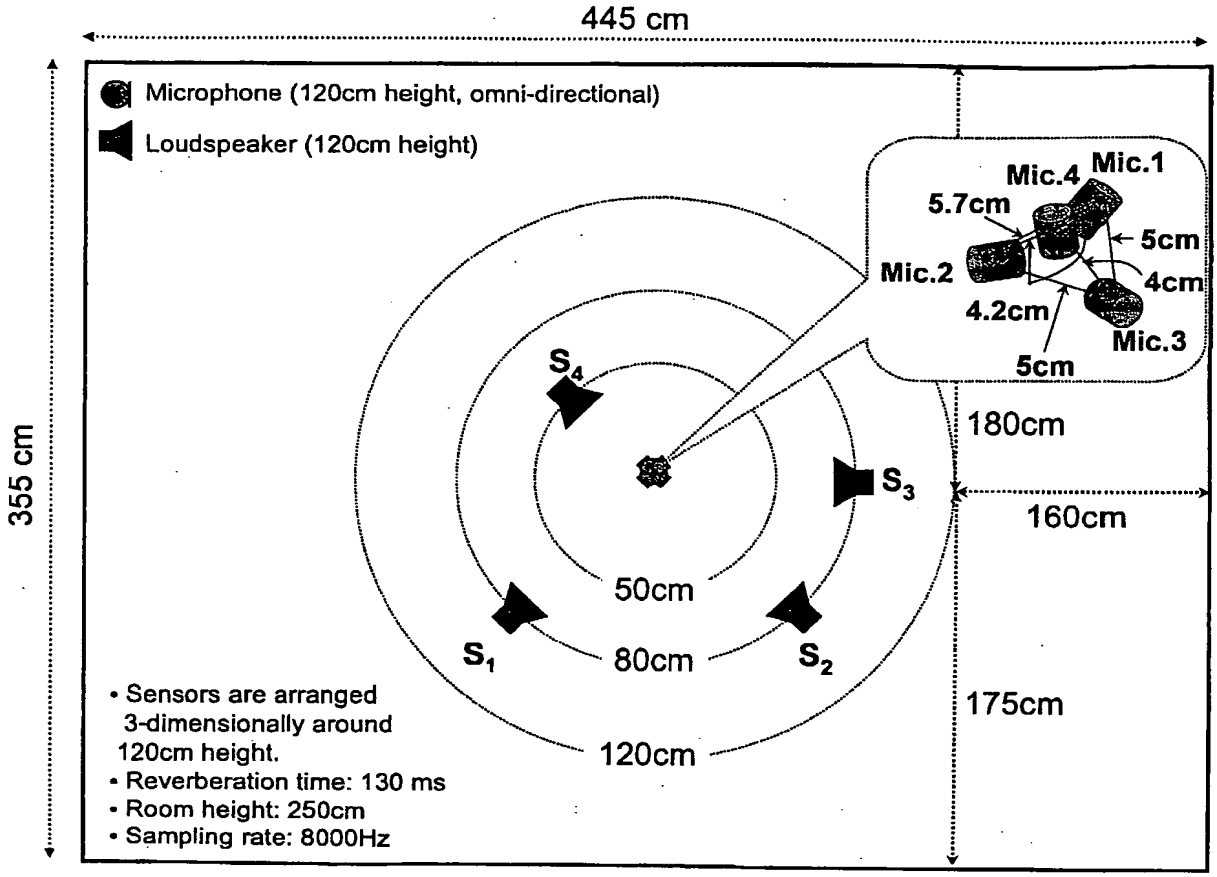


FIG.41B

EXPERIMENTAL RESULTS (in[dB])

	SIR_1	SIR_2	SIR_3	SIR_4
InputSIR	-8.1	-5.3	-6.6	-0.6
Proposed	17.8	15.6	9.6	15.7